THE REFINER AND NATURAL GASOLINE MANUFACTURER

In This Issue

Paint Brush and Conservation

There are many angles to conservation and one that is getting much attention from refineries and gasoline plants is that of proper and sufficient protection for exposed surfaces. Special paint departments are not new in the industry and much research has been done in determining the most desirable paints, etc., to meet the severe requirements of high temperatures and acids. In this issue are a number of articles dealing with this subject giving some valuable hints to those interested in this type of conservation.

Vol. 5 No. 7 JULY, 1926 $1.00 Per Year

Applying the insulation on Class IV Cars

Leaders for Over 60 Years

"Car Foundry" TANK CARS

Look Ahead!

RAILROADING today demands greater durability in tank cars than ever before. The increased average daily mileage would be reflected in increased wear and tear and more A. R. A. repair bills were it not that "Car Foundry" tank cars are built to meet not only the strenuous present-day conditions but also probable conditions of the future.

The tank car factors that count are long and dependable operation, minimum loss of service for repairs, and low cost of maintenance. "Car Foundry" construction is based upon these requirements —with a liberal margin of extra strength for the hard service of the years to come.

Send for leather-bound looseleaf booklet of recent "Car Foundry" constructions. If you wish to see our representative, please so state.

Always Get a "Car Foundry" Quotation

American Car and Foundry Company

30 Church Street, New York — Railway Exchange Building, Chicago — 915 Olive Street, St. Louis

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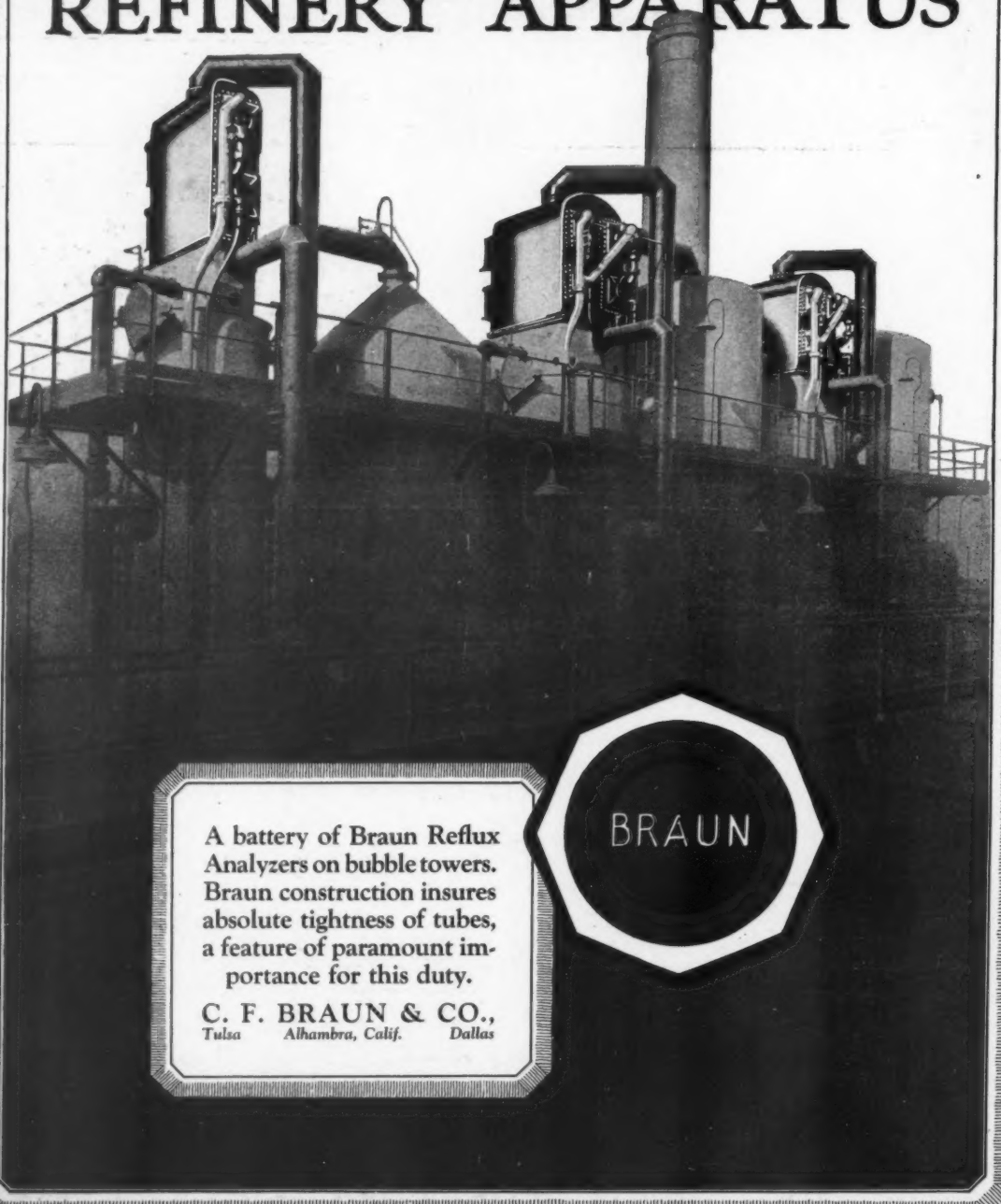
BRAUN
REFINERY APPARATUS



A battery of Braun Reflux Analyzers on bubble towers. Braun construction insures absolute tightness of tubes, a feature of paramount importance for this duty.

C. F. BRAUN & CO.,
Tulsa *Alhambra, Calif.* *Dallas*

BRAUN

Entered as second class matter June 16th, 1923, at the Postoffice at Houston, Texas, under the Act of March 3, 1879.

SIL-O-CEL
HEAT INSULATION

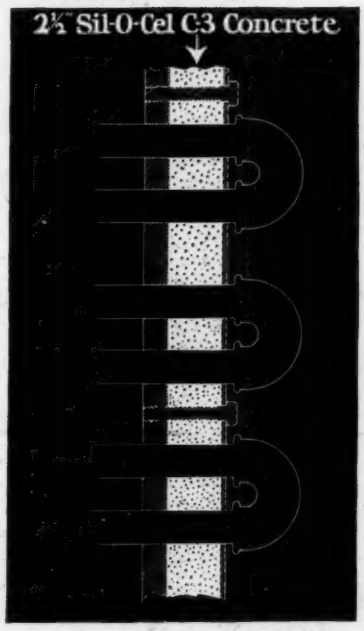
Insulation of Tube Plates in Cracking Coil Furnaces

SIL-O-CEL INSULATION respects no structural limitations.

Any hot surface that wastes heat to the atmosphere can be effectively insulated with one or another form of this material.

It makes no difference whether this surface be brick, steel or concrete. Projecting rivet heads or piping connections offer no serious handicap. The only requirement is the space itself that will be occupied by the insulating material.

THE INSULATION of cracking coil tube plates, for example, is simplified by the use of Sil-O-Cel C-3 insulating concrete as illustrated in the drawing reproduced at the right.



Molded on the Job

This form of Sil-O-Cel insulation, made by mixing granular calcined "C-3" material with small quantities of Portland cement, can be cast in any desired form right on the job.

Within twenty-four hours it sets to a firm coherent mass, which, after drying, forms an effective barrier to heat penetration that will withstand direct temperatures as high as 1800° F.

There are a dozen other places in refineries and gasoline plants where Sil-O-Cel "C-3" material effectively solves the insulation problem.

For Furnace Bases, Doors and Dampers

In the bases of stills, topping units, boilers and furnaces Sil-O-Cel C-3 is used, either as a dry filler or as insulating concrete beween the fire brick and the Portland cement concrete, to form an effective seal against heat radiation losses into the ground.

It is used to make light weight furnace doors that are five times as effective at stopping heat radiation as cumbersome doors of fire brick construction. Its durability and light weight also earn it wide favor for the construction of dampers in flues and hot gas mains.

A new Engineering Service Bulletin on the many applications of "C-3" and "Insulating Concrete" has just been published. Write our nearest Division Office, listed below, for this booklet, No. R-115, and a sample of "C-3 Concrete."

CELITE PRODUCTS COMPANY

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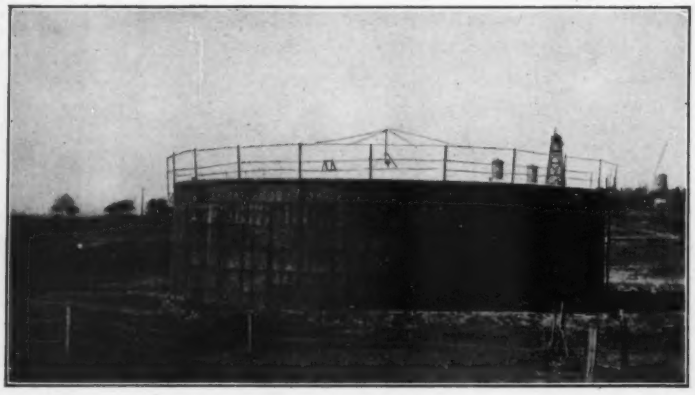
Lightning protection

for your Tankage



SAFEGUARD your tankage against lightning fires. We have developed effective protection for wood deck tanks by means of grounded conductor network (patents pending) shown above.

Complete information on request.

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Branches in all large cities For Canada: Canadian Johns-Manville Co., Ltd., Toronto

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Oil Industry Department

Mention Where You Saw the Advertisement

Cracks off scale *automatically!*

The G-R Bentube Section

(Patented and Patents Pending)

for cooling gas, oil, or jacket water, and for condensing vapors, is the greatest improvement ever made in atmospheric type coolers or condensers.

Scale formed on the outside of the bowed tubes is automatically cracked off by the pronounced flexing of the tubes or change in temperature by admitting steam to the tubes.

All Bentube sections are standard and interchangeable, provide for expansion, drainage and easy cleaning, and can readily be moved about as required by changes in plant layout.

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R 7-26

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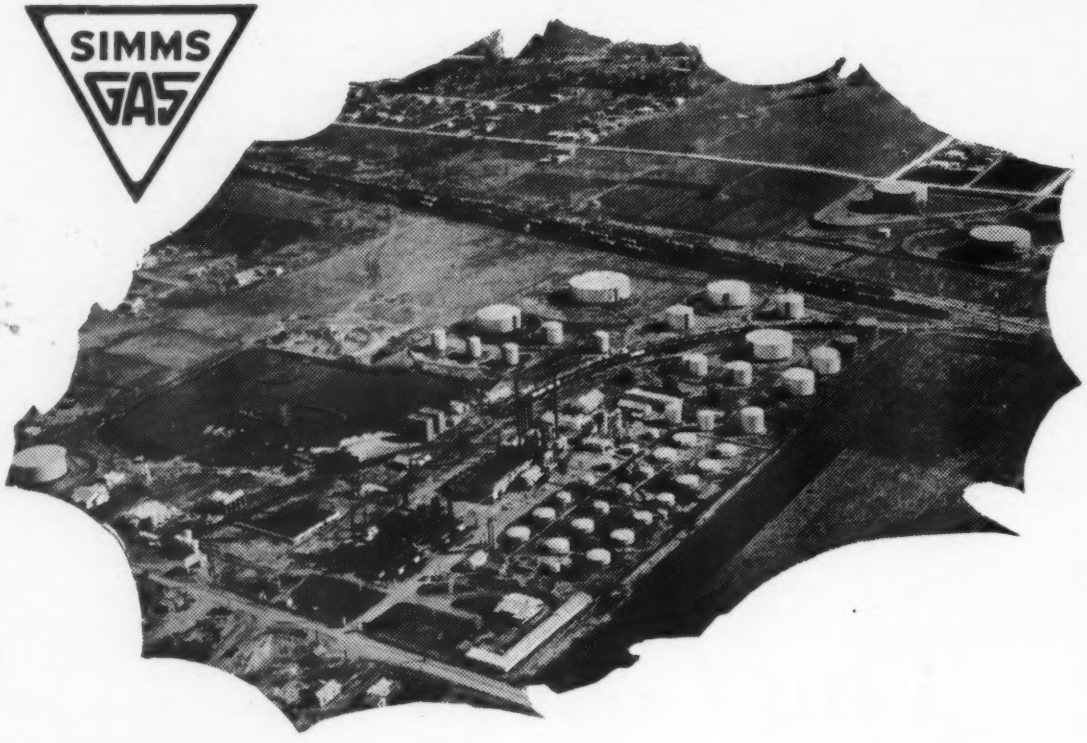
SIMMS GAS



The Simms Refinery at Dallas Painted With

SAFEMCO

SAFEMCO Refinery Paints

We Invite Correspondence On—

Storage Tank Paint
Tank Car Paint
Pipe Coating
Metal Roof Paint
House Paint
Any Special Made Paint

THE Simms Refinery at Dallas is a model of paint beauty and efficiency according to H. H. King in an article in the Refiner.

The plant was painted throughout with SAFEMCO Aluminum, Blue and Red—the trademark colors of the Simms Company. It is a remarkable advertisement as well as an economical protection for the property.

What SAFEMCO did for Simms, it can do for you.

AMERICAN PAINT & SUPPLY COMPANY

Oil Industry Paint Specialists

DALLAS, TEXAS

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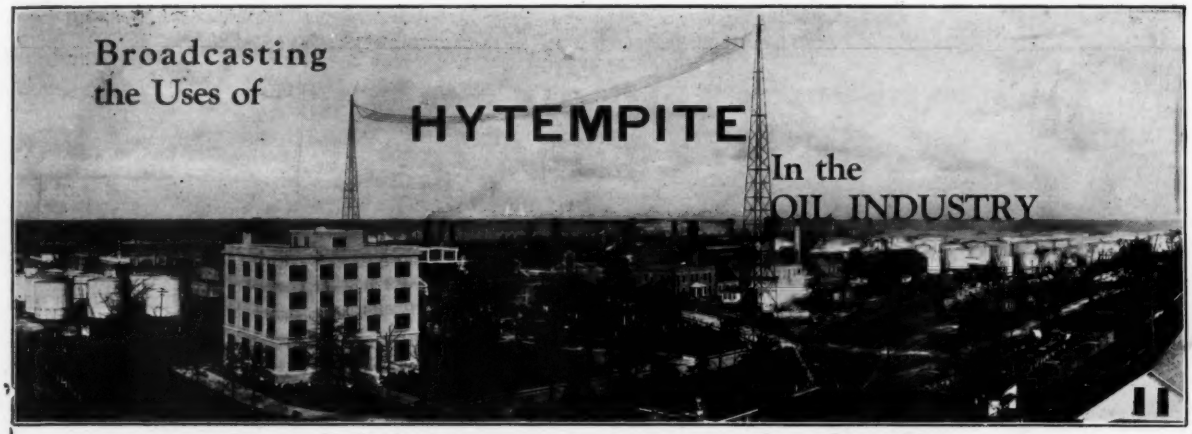

On Firebrick Construction an Authority Says:

"High temperature cement has to a great extent taken the place of fire clay—especially where extreme conditions are to be met. This cement unites the brick into a solid wall, protecting the brick from disintegrating under extreme heat."

HYTEMPITE

(Reg. U. S. Pat. Off.)

"The Standard for Comparison" in High Temperature Cements forms a lasting union between refractories. The thin **HYTEMPITE** joint bonds at normal temperature and the bond extends through the entire thickness of the wall or arch. The strength of the bond is increased by heat up to temperatures at which the best quality of fire brick will soften or fail.

HYTEMPITE is used for

1—Laying fire brick and tile.
2—Repairing and rebuilding furnaces.
3—Making monolithic baffles.
4—Making special shapes, tile, etc.

Some Users of HYTEMPITE

Standard Oil Company
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Gulf Refining Company
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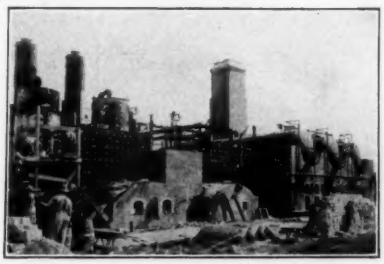
Atlantic Refining Company
Humble Oil & Refining Company
Cosden & Company
Marland Refining Company
Vacuum Oil Company



HYTEMPITE used on all fire brick work in these stills.

Ask for illustrated bulletin on how to lay fire brick and tile, repairing and rebuilding furnaces, making monolithic baffles, special shapes, tile, etc.

QUIGLEY FURNACE SPECIALTIES CO., Inc.

26 CORTLANDT STREET NEW YORK CITY

Stock and Service in every Oil Field and Industrial Center

Compare a Bessemer With Any Other, Point by Point

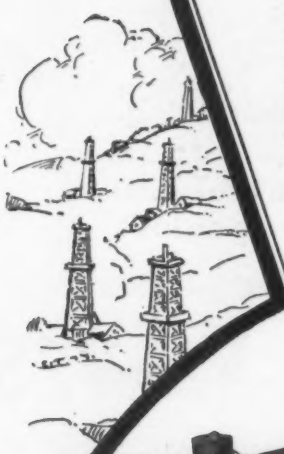
THERE is only one conclusion possible after a point by point analysis of a Bessemer compressor with others—they are *better* built units with a much higher operating and compression efficiency—horsepower for horsepower, inch for inch displacement.

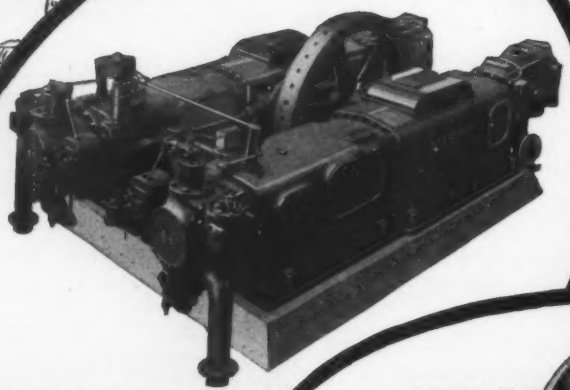
On both the Two Cycle and Four Cycle units typical Bessemer crosshead construction with adjustable shoes and bearings, is used throughout. All bearings are extra large, all parts are over strength, and the complete units are entirely enclosed with all parts made easily accessible for adjustment or replacement.

The compressor cylinder is the new, improved Bessemer type used on all Bessemer direct driven compressor units. These cylinders have a compression efficiency unequalled by any other cylinder and they retain their high initial volumetric efficiency without repair or replacement during remarkably long periods of service.

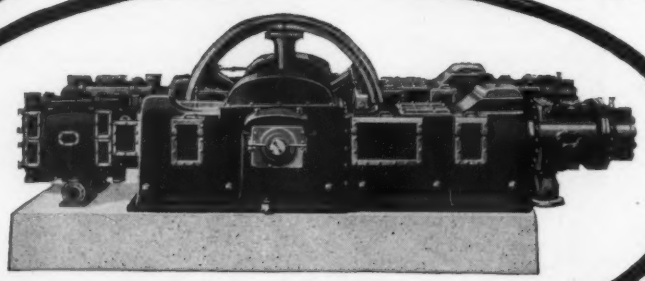
In every detail of engineering and construction, as a point by point operating comparison will show, Bessemer direct driven compressors (both Two Cycle and Four Cycle) are far in advance of even the next best.

THE BESSEMER GAS ENGINE COMPANY
18 York Street ∴ ∴ Grove City, Pa.





Bessemer Four Cycle Compressors have a remarkably simple valve assembly which assures high engine efficiency, low fuel consumption and trouble free service. They are ruggedly built to deliver years of uninterrupted service.

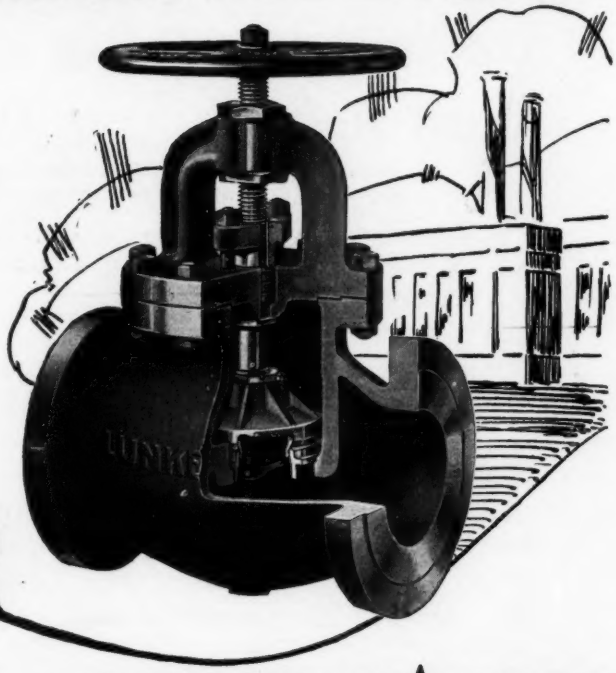


Bessemer Type Ten Two Cycle Compressors are the standard of the natural gasoline industry. Their running time is consistently 99% plus, and their maintenance almost nil.

BESSEMER COMPRESSORS

MINIMUM MAINTENANCE EXPENSE INSURES MAXIMUM ECONOMY

The name "Lunkenheimer" on a valve immediately identifies it as a long life valve—one that will render continuous satisfactory service, with the least amount of attention, and without frequent costly repairs and replacements.



LUNKENHEIMER GLOBE, ANGLE AND CHECK VALVES

are standard equipment in thousands of plants because of their economical performance over long periods of time. Once installed, they require very little attention; they stay tight, and maintenance expense is negligible. Procurable in bronze, iron or steel, in all standard sizes, for all prevailing pressures and temperatures. The extensive line provides a selection of the correct valves for any service.

Lunkenheimer Distributors are located in all commercial centers, and render prompt service right from stock. Call on them when in need of Valves, Boiler Mountings and other Engineering Appliances.

Have you a copy of the "Guide to Better Service?" It's a valuable book, showing in convenient form an ideal selection of Valves and Engineering Appliances. The center pages illustrate the application of Lunkenheimer Boiler Mountings conforming to the A. S. M. E. Code. A copy will be sent without obligation. Just fill in and mail the coupon.

THE LUNKENHEIMER CO.
"QUALITY"
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EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

Fill in and mail this coupon for your "Guide to Better Service."

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Please send me a copy of Lunkenheimer "Guide to Better Service." HJ

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Economic Service

KAW Refinery Equipment Built to Save You Money

THE strength and durability of KAW Refinery Equipment makes certain of long, economical service. No matter where you find KAW products you'll always find them delivering maximum utility at lowest cost.

Full yield of this economic service is guaranteed by the KAW policy of building super-strength into every piece of KAW equipment. It is an economic service predetermined in the design and fabrication of every pound of steel used in constructing KAW products. Emergencies serve only to emphasize it.

The sureness with which KAW products maintain their operating fitness is revealed day after day through actual service to refiners everywhere.

We can supply you with High Pressure Stills, Condenser Boxes, Agitators, Storage Tanks, Towers, Stacks, Rundown Tanks and other standard equipment—all backed by KAW'S assurance of longer, better service.

Write, wire or phone!

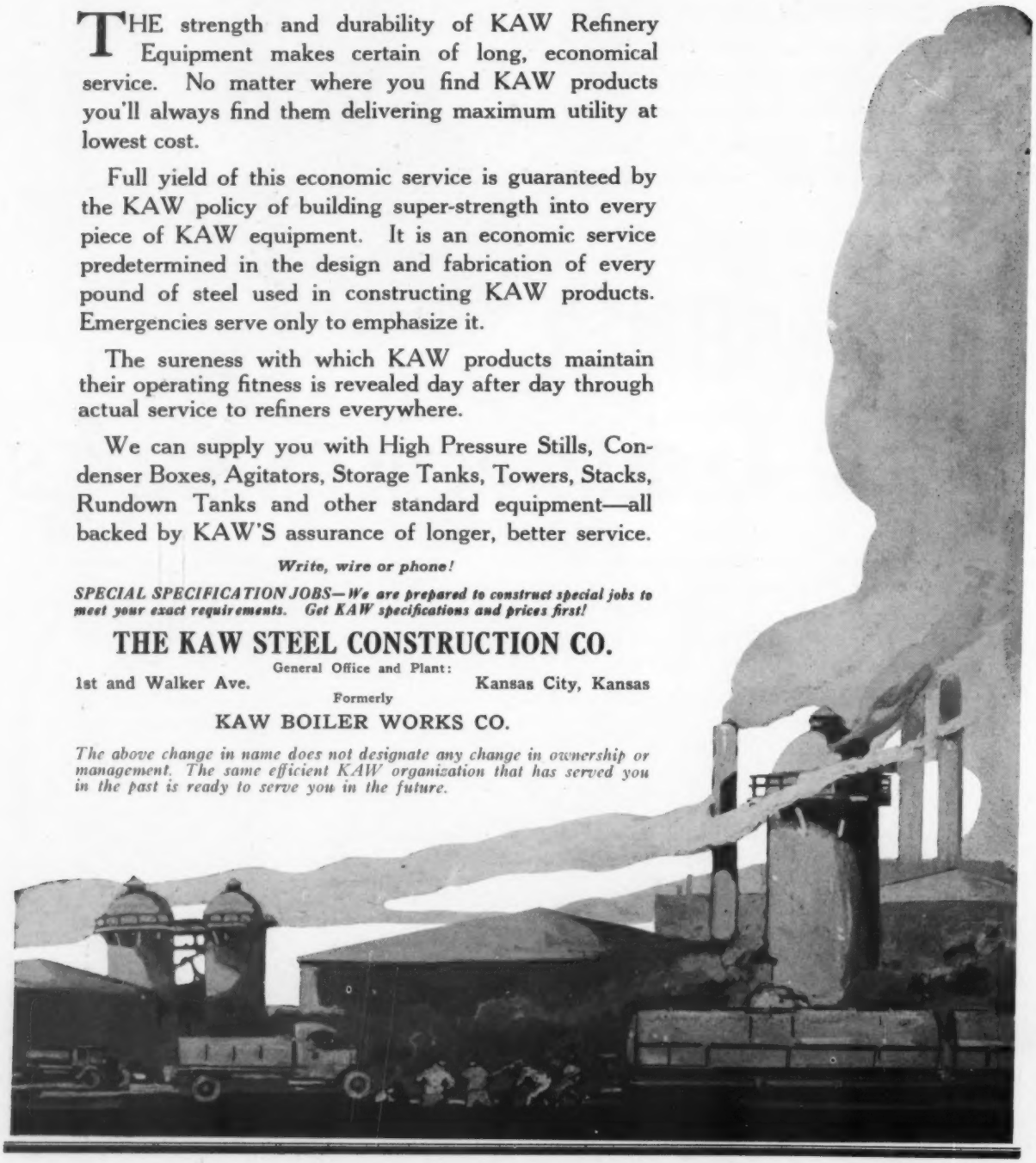
SPECIAL SPECIFICATION JOBS—We are prepared to construct special jobs to meet your exact requirements. Get KAW specifications and prices first!

THE KAW STEEL CONSTRUCTION CO.

General Office and Plant:
1st and Walker Ave. Kansas City, Kansas

Formerly
KAW BOILER WORKS CO.

The above change in name does not designate any change in ownership or management. The same efficient KAW organization that has served you in the past is ready to serve you in the future.



A section of the A. O. Smith Chemical Laboratory. Steel must first meet the approval of these laboratories, and others, before it is considered fit for Smithsteel Cracking Stills.

Modern Laboratories Insure the Quality of SMITHSTEEL Stills

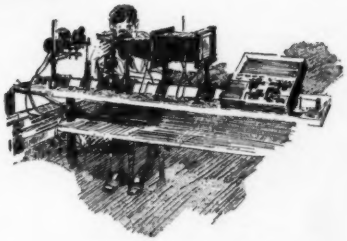
Only in Smithsteel Cracking Stills is it possible to secure any size, any wall thickness to meet any specified pressure requirements for all operating conditions.

With the building of pressure vessels to these unlimited demands of the industry, there comes an additional need for accurate control of the quality of steel which goes into them.

Here at the big Smith Plant steel that goes into Smithsteel pressure Vessels must pass the exacting tests of chemists and metallurgists working in fully equipped laboratories. No precaution is thought too great, no means is neglected in making certain that Smithsteel Stills will withstand with safety the strenuous demands to be placed upon them.

Care in specifying steels, close adherence to specifications by testing, care in carrying out the exclusive Smith methods of construction are responsible for the production records Smithsteel Cracking Stills are making today.

A. O. SMITH CORPORATION • *Milwaukee, Wisconsin*
TULSA • LOS ANGELES



Micro-photographs help to check quality of steel used in Smithsteel Stills.

Any Wall Thickness Required

Smithsteel Pressure Vessels can be built in any wall thickness, in any diameter and of any length, to withstand any specified pressures to meet all operating conditions.

SUNOCO

Absorption Oils 630 and 670

Developed to meet the recent improved methods in the manufacture of Natural Gasoline, have been established as valuable allies to the Natural Gasoline Industry.

By their use will be obtained:

Better fractionation.
Greater heat transfer.
Increased yields.

A representative of our Engineering Department will call upon request.

SUNOCO

SUN COMPANY

Petroleum Bldg.,

Tulsa, Oklahoma

Refineries at

Marcus Hook, Pa. Yale, Okla. Toledo, Ohio

Many times a day this Pennsylvania Forge Hand Book is consulted by power engineers, fabricators, and men in kindred lines. A free copy awaits your request.

Accept this Authoritative Hand Book

YOU'LL FIND it mighty convenient to have this new, compact manual within reach, if you are concerned with the fabrication, installation, or upkeep of pipe lines.

Contains tables of A. S. M. E. standards on pipe and boiler flanges, along with prices on each size; standard pipe specifications, bends for steam lines, and a mass of kindred data—48 pages in all.

Your name on a postal will bring you a copy, with our compliments.

The book also tells briefly of the superior character of Pennsylvania Forge Flanges and why the engineering trend is toward forged flanges everywhere.

Pioneers in the development of forged steel flanges, we have, by 16 years of unflagging effort, evolved an organization that can be relied on for flanges of exceptional workmanship, and for prompt deliveries.

It will pay you to send us an inquiry on your next order for flanges.

Meanwhile, write for this valuable free data book

The strength of the line is only PFC *the strength of the Flanges*

PENNSYLVANIA FORGE CO.

PHILADELPHIA

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Why Is It?

That Silvr-Cool, the Super aluminum paint, wins out in test after test?

Silvr-Cool wins not only because of its bright silvery finish, and other characteristics which make it stand out from the ordinary—but because observation, year after year, proves its exceptional durability—its unusual protective qualities—its long life—and its low per year cost.

Why—because Silvr-Cool is not an experiment—it is a high quality, service proven product—made by a manufacturer who is universally recognized and rated at the top in the production of protective coatings.

Use Silvr-Cool for utmost service and satisfaction in aluminum paint.

SILVR-COOL

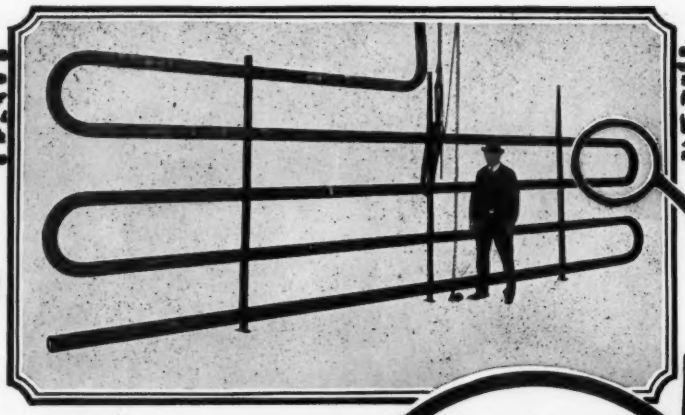
The Super-Aluminum Paint

—IS MADE BY—

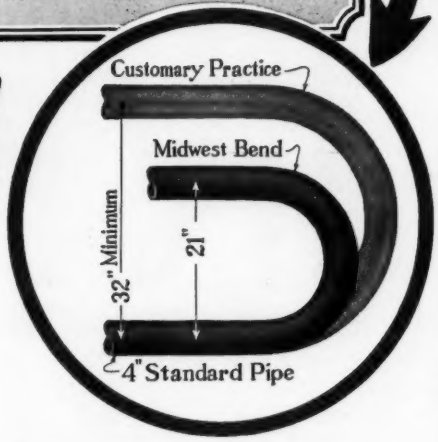
Detroit Graphite Company

DETROIT, U.S.A.

WAREHOUSES AT ALL PRINCIPAL CENTERS



34% of Space Saved



A NATIONALLY KNOWN oil refining company required a large quantity of condensing coils made from 4-inch standard weight steel pipe. Return bends were not wanted due to the possibility of leakage through joints and threads. The center-to-center distance desired was 21 inches, which necessitated the very short U-bend radius of 10½ inches—as indicated by the sketch above, the minimum radius of customary practice is 16 inches.

One of the country's largest pipe fabricators stated positively that these short radius bends could not be made. Midwest Engineers, however, developed a special method which successfully produced the bends as desired. Midwest Piping Service thus reduced the coil center-to-center distance 34% and effected an equal saving in space and made a corresponding reduction in the cost of the coil tanks.

All joints of these condensing coils have two courses of electric welding—the first course was thoroughly caulked with an air hammer. The coils were subjected to severe hydrostatic tests before shipment.

* * * *

If you are confronted with a piping problem, the Midwest Piping and Supply Company can be of very definite service to you. This organization devotes its entire ability, energy, and time to pipe fabrication and the solution of piping problems. Our engineers are trained "pipe men" and their long and varied experience is at your command.

* * * *

And if you know exactly what piping you require, we will follow your instructions accurately and intelligently.

So—write, wire or phone for Midwest Service when you need fabricated piping.

MIDWEST PIPING & SUPPLY COMPANY

Second and Miller Sts., St. Louis, Mo.

CHICAGO OFFICE: 208 So. La Salle St. TULSA OFFICE: 805 Mayo Bldg.

Fabricators of Oil Refinery, Natural Gasoline Plant and Power Piping

MIDWEST Piping Service

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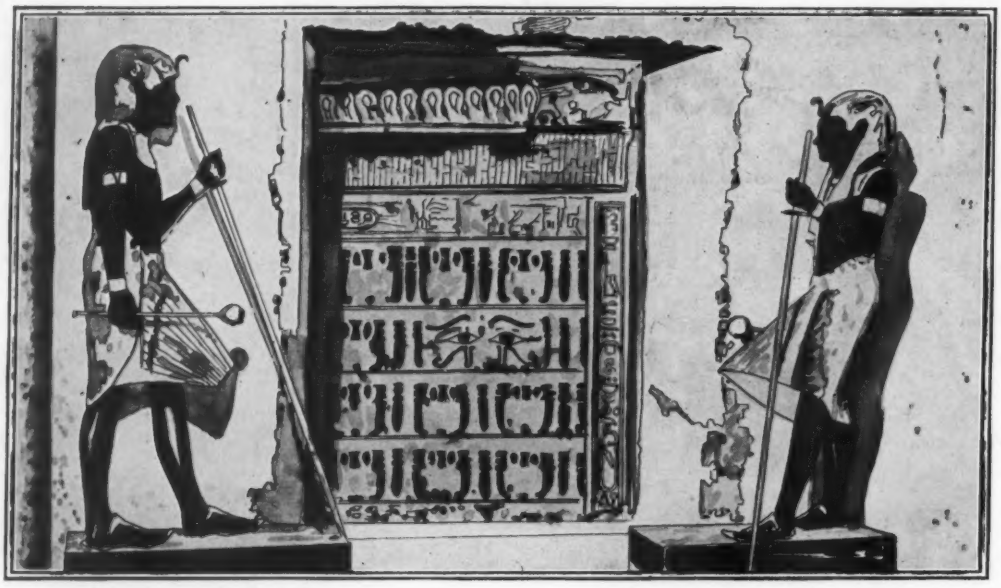

THE DAY OF THE PHARAOH

PETROLEUM played an important part in the civilization of the Egyptians, just as it does in ours of today. It played an important part in their secret process of embalming and, in the illustration shown here, it was used as a coloring for the figures of the black kings standing guard over the tomb of Tutenkhamon.

It was many centuries later that its greater value to mankind was discovered, and when, by the process of refining, gasoline was produced, the internal combustion engine followed.

The importance of this invention upon civilization was so great that it has changed the character of the people, their customs and habits and their mode of living. It has revolutionized commerce, determined the outcome of war and the supremacy of nations.

The discovery of Natural Gasoline supported and advanced still further the great value of this wonderful resource. Natural Gasoline is the infant product of the Oil Industry today. It is only twenty-two years old, but from the year 1903, when it was first made back in Pennsylvania, to this present day of grace, 1926, nearly one billion and a quarter gallons have been manufactured. One wonders what the future holds.

CHESTNUT & SMITH
CORPORATION
TULSA, OKLA.

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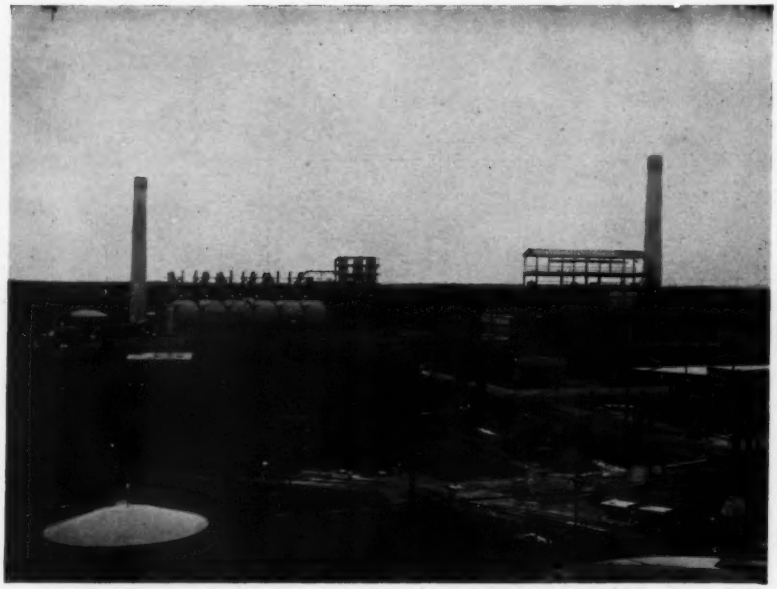

–and in the Argentine

A recent issue of Refiner and Natural Gasoline Manufacturer recorded the starting up of an oil refinery, with a capacity of 2000 tons of crude oil daily, by the Argentine Government,—estimated cost of the plant more than nine and a half million dollars.

Lagonda Cleaners were a part of the original equipment of the plant, which was bought in this country through the Bethlehem Steel Company.

Oil men consider a good tube cleaner an indispensable part of the equipment of the modern cracking still. The hard coke deposits must be removed periodically from the tubes, and the cleaning must be thorough and speedy.

Lagonda Cleaners everywhere have been found thoroughly capable. They are used in all makes of stills and in the other pipes and tubes used in the refining process, as well as for the cleaning of boiler tubes. They are furnished in sizes and types and with cutting heads suited to the particular kind of scale to be removed and the service required of the Cleaner.

The Lagonda Mfg. Co.
SPRINGFIELD, OHIO.
FUEL SAVING SPECIALISTS
NEW YORK, CHICAGO, PHILADELPHIA, BOSTON, PITTSBURGH, CLEVELAND CINCINNATI, DETROIT, SYRACUSE, BALTIMORE
ST. LOUIS, KANSAS CITY, DENVER, DALLAS, ATLANTA, SAN FRANCISCO, MONTREAL, LONDON.

Makers of Lagonda Boiler Tube and Condenser Cleaners, Tube Cutters, Cap and Header Reseating Machines, etc.

X-1412

Lagonda Cleaners

Mention Where You Saw the Advertisement

COOPER

Why We Did Not Reduce Prices!

SIX MONTHS AGO we were faced with a suggestion to lower prices still further. A steadily increasing sales volume, greater purchasing power and still better production tools and methods would have made an additional reduction possible. A careful study of the situation revealed that engine buyers had always recognized a higher quality in COOPER ENGINES, and in a majority of cases had been willing to pay extra for a better engine. We were convinced that what the trade wants is still better gas engines at reasonable prices—not necessarily cheaper engines.

Instead of reducing prices, we more than added the savings, due to manufacturing methods, to the materials in the engines. Today the materials in a COOPER 170 H. P. engine are costing several hundred dollars more than they did a year ago. Alloy steels, more drop forgings, and semi-steel to replace cast iron, are being used to make still better engines. A COOPER engine now represents a better value than ever before during the 93 years we have been building power machinery.

THE C. & G. COOPER COMPANY

HOME OFFICE, MT. VERNON, OHIO

1605 Kirby Bldg., Dallas, Texas

504 Kennedy Bldg., Tulsa, Okla.

Bank of Italy Bldg., Los Angeles, Calif.

ENGINES

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Tulsa, Oklahoma

Publication Office:
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The REFINER and NATURAL GASOLINE MANUFACTURER

EDITED MONTHLY AT TULSA, OKLAHOMA

GRADY TRIPLETT, *Editor*

Published by

GULF PUBLISHING COMPANY
HOUSTON, TEXAS

R. L. DUDLEY, *President* A. L. BURNS, *Gen'l Mgr.*

Vol. 5 JULY, 1926 Number 7

For men engaged in the operating branch of the refining and natural gasoline business

Price.....$1 per year

Advertising rates upon application to nearest office

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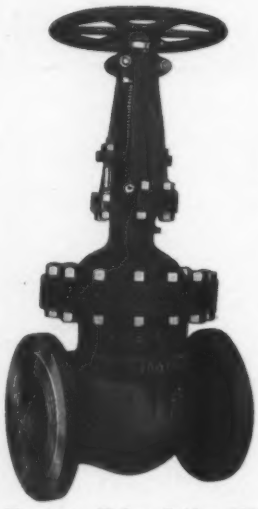

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Series 300

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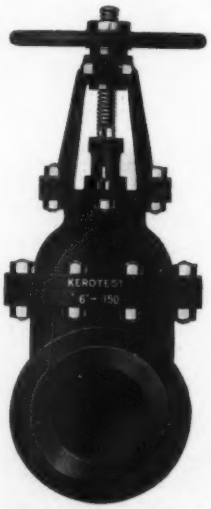

Kerotest Valve Series 150

Write for the Kerotest folder describing this new line of Refinery Valves

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Pittsburgh, Penna.

Mention Where You Saw the Advertisement

New Pacific Coast Refinery Offers Engineering Advances

Western Oil and Refining Company has fire box independent of internally fired still

By George Reid

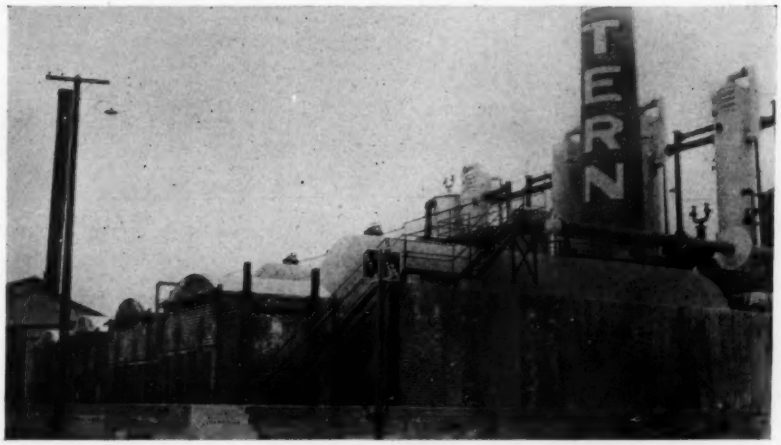
THE Western Oil & Refining Company, operating a 5000 barrel refinery at Wilmington, Cal., has incorporated in the construction and operation of this installation, some interesting features. The latest approved engineering principles have been adhered to, resulting in the installation of modern, efficient equipment in all departments. The plant was constructed along the lines of the unit system, and provision has been made for the enlargement or doubling of capacity of every department; such expansion work being possible without interfering with the performance of any of the present working equipment.

The plant is situated on a high bluff overlooking the West Basin (deep) water) of the Los Angeles harbor area; where, just below the plant, the company has secured docking frontage. One hundred acres are included in the plant site which has been leased for 99 years.

The tank farm erected on the property for storage of both finished oils and crude petroleum has a capacity of 330,000 barrels. Pipe line connections have been secured with several nearby oil pools—Signal Hill, Dominguez, Athens, Torrence, etc. The plant is operating on contract crude.

Laboratory Segregated

In line with the trend of all progressive refiners, the company has employed a technical staff and provided for them, a modern laboratory. The department is isolated and surrounded by a fence, inside of which enclosure are constructed miniature refining plants, filtering apparatus, treating equipment, etc.; where experiments in distillation, fractionation, treating, lube oil compounding, etc., are first carried out on a small scale to test the adaptability of new processes before installation in the plant proper. The brick building, which is fire proof, houses the general testing department in three rooms.



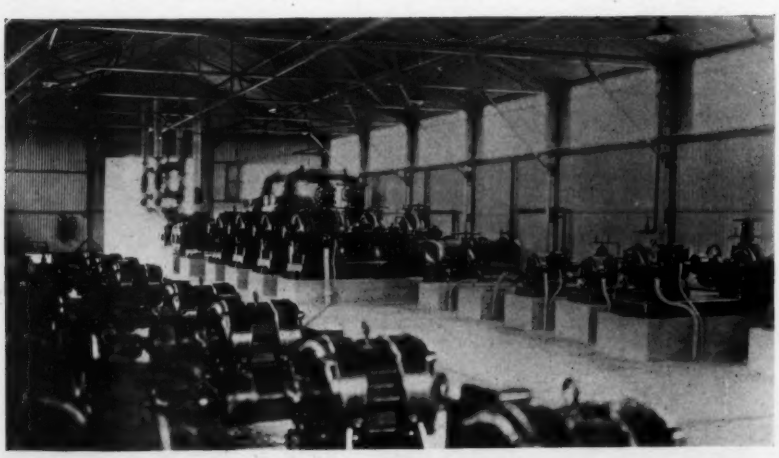
Distillation equipment showing internally fired stills

The power house, which supplies steam for the entire plant, certain large pumps and stills, consists of two 264 horse power Collins water tube boilers. It is said that this is the first commercial installation by Southwestern Engineering Company of this type of boiler.

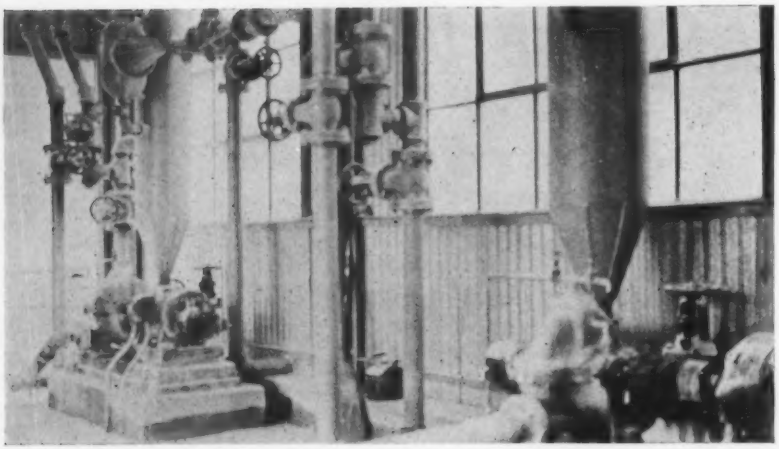
The distillation equipment consists of four large shell stills, which are of the latest type of internally fired still. The internally fired still is, in general, nothing startlingly new in the refining industry but as this equipment is designed along different lines than usually found with other organizations, it is worthy of a brief description here.

Also, it is of interest to note certain items in the history of the adoption of the internally fired still as employed in the Refining industry. The installation of the usual shell still internal flue is essentially one of the devices used by several companies in their endeavor to increase thermal efficiency and to thus decrease fuel consumption. This method was first employed by the Royal Dutch Shell interests in certain European Refineries. In America, the Standard Oil Co. of New Jersey, Standard of Louisiana, Humble Oil & Refining Co., and the Imperial Oil Co. Ltd., of Canada have employed similar equipment. The usual method requires firing directly under the still as is commonly done, then conducting the hot gases of combustion back through the still to a stack erected in front of, or on the still setting. This requires a separate stack for each still. The various methods commonly employed differ only in the size and number of return tubes running through the still.

Originally, two large tubes were employed, then the refiners decreased the size of the tube and increased them in number. One type of Humble Oil & Refining Company still, for example, has several 10 or 12 inch return flues running through the shell, some of which are covered by the oil being distilled and some of which are high in the still above the oil level. The tubes are in two banks, staggered, and arranged to permit ease in cleaning. A double boot, or baffle at the rear of the still is sometimes provided

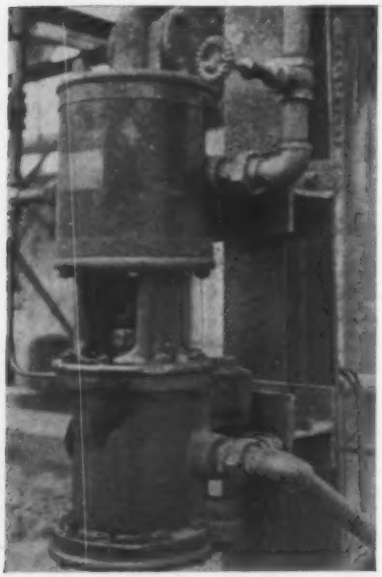


Interior of main pump house, showing motor driven pumps for transferring water white distillate and l'ght oils



Lower floor of contact filtering system, showing electric pumps and mixing chambers

to separate the hot gases into two streams before they enter the tube banks. Other designs merely provide a box like space at the rear of the still consisting of steel doors, which are raised occasionally when it is necessary to blow accumulated soot etc., from the flues. Some designs provide for conducting the hot gases entirely



Air brake type of compressor, suspended to steel beam

above the boiling oil, others entirely below the oil surface or level.

Fire Box Separate

The Western Oil & Refining Company installation is somewhat different in design.

The fire box or Dutch Oven is entirely independent of the still proper, being constructed as a separate unit and connected to the still only by the flue gas channels. This large, well insulated, furnace is the combustion chamber and through the empoyment of this device it is impossible to fire directly against the still bottoms, or against the two flue gas conducting tubes. Leaving the combustion chamber, the hot gases are first conducted through two large flues, four feet in diameter, which are corrugated inside. The flues, 40 feet long, extend through the still below the oil level, and as they represent the hottest area in the still the steam coils are placed on top of them, instead of at the still bottom as usually installed. The hot gases upon reaching the rear of the still are kept separated in two streams by a baffle and are caused to flow back to the front of the still in a compartment especially designed, where the sides of the still shell are exposed to this heat, this is another travel of 40 feet along the still wall, and outside of the shell. Then at the front end of the shell they are caused to come together by baffle walls, to form one stream of hot gases and to pass again to the rear of the still; this time in a channel directly under the still bottom, or a third travel of 40 feet.

In this way the hot gases must travel 120 feet, being exposed to the still surface in some manner all the time, before they enter the stack. And in the manner described is shown how the stills are thoroughly heated without firing against the steel shell at any time. Some idea of efficiency is shown in these figures, still furnace temperature 1100 F.; hot gas temperature at still bottom where two streams of gases unit, 700 F.; temperature at entrance to channel conducting gases to stack, 500 F.; stack temperture for all four stills,—(the fourth still operating at about 525 F.), 600 degrees F. Inspection of the fire boxes or Dutch ovens showed the fires to be almost "loafing", with the plant operating at 5000 barrels daily. Another item which is different in this installation is the use of one large stack for all stills as differing from the use of one stack for each still. It is

Fractionating equipment and condensers. The foremost tower is used as vaporizer and separator

claimed that the plant is operating with an overall fuel oil consumption, including boilers, of two per cent.

Fractionating Equipment

The crude oil is run continuously through the four stills, distilling gasoline, kerosene, and heavy distillates. Each still is equipped with a 24 hour Foxboro temperature recorder. The incoming crude is charged over the tops of the towers through controller sections (vapor heat

(Continued on page 38)

Laboratory and miniature refinery for experimental work

Special Products Built This Business

By Grady Triplett

AROUND the Orient Petroleum Company at Wichita Falls, they refer to the plant output as "tailor made products." That is another way of saying that refinery operation is confined to special products.

While gasoline is made on established specification, the company does not offer the most common refinery product, U. S. Motor gasoline. Export specification gasoline is manufactured, as well as some other grades. Each of these is of higher gravity than U. S. Motor.

The term, "tailor made" has its chief application to the 18 grades of special naphthas, manufactured for uses outside the common petroleum needs. These are for paint manufacturers, varnish makers, soap factories and cleaning establishments.

The business of the concern has been built by making these special products and finding a market for them, or rather catering to a market that has been little considered by the independent refining industry of the Mid-Continent section.

The Orient Petroleum Company may be classed as not yet five years old, although the plant is older. It was built during the boom days of North Texas in connection with the Burkburnett development and of course was intended for operation as a plant of the ordinary products.

Beating the Market

Development of the special products for uses largely outside ordinary refinery outlet, followed the efforts of W. F. Davis, vice-president and counsel, to find some method of operating a refinery without being at the mercy of the market.

"When we took over this plant," he said in explaining how and why the business was developed, "we saw the need for a type of market that would escape the plight of the independent refinery. Four years ago conditions were worse than today. A plant would run a few months and seem headed for a prosperous year. Then would come market reverses, with lower prices, reduced shipments, full tanks and frequently an idle plant. Under those conditions few plants made money, some broke even, while others showed an annual loss."

In analyzing this situation, Mr. Davis was struck with the fact that the independent refining industry was engaged largely in making a few products, each plant catering to a common market. U. S. Motor gasoline, some kerosene, gas oil and fuel oil were the ordinary products, a condition that exists today.

"But we knew there were uses for refined products outside these common grounds," he continued. "So we began to study these market possibilities. Right off we ran into the needs of makers of paints and varnishes. Naphthas for these uses have been made for many years. But the larger refining concerns in the East were supposed to be the only ones capable of filling these needs, for these naphthas must meet very close specifications. And the product must meet the specification. There is no such thing as making an adjustment when specifications are not right."

New Paths

Mr. Davis personally made a tour of the territory, where these products are needed and learned from paint, varnish and soap manufacturers what their naphtha needs were. At the time of making these inquiries, no sales efforts were made.

"We knew we could make their products," said Mr. Davis, "or later we could add equipment to permit making these products. So all we needed at the time was specifications on their needs."

With specifications of these special products in hand, there followed a manufacturing and sales campaign that is no doubt unique in independent refining circles. Back at the Wichita Falls plant, the chemist and operating men were set to experimenting on naphthas of the specifications gathered. A miniature still was set up, to allow turning out samples large enough to draw the attention of the possible buyers.

Frequently naphthas were distilled with the laboratory equipment, only a quart sample resulting from the operation. But this allowed the sales effort to begin through the delivery of samples. The market was then built on samples of a quart, a gallon or a barrel.

Taking the naphtha needed by a varnish concern, a sample would be produced and sent to that plant. Sales efforts frequently were by letter, explaining that the Orient company could supply that product in sufficient quantities to supply the yearly needs of the varnish manufacturer.

Slow But Sure

While it was a slow process, a market gradually was developed on naphthas. Usually larger samples followed the quarts. Finally came orders for tank cars.

On gasolines, it was not necessary to work so slowly to find outlet, but it was necessary to find jobbers and filling station owners, whose business demanded gasoline of high quality for a constant demand.

In 1925, 60 per cent of the gasoline output of the Orient plant went to Europe, the gasoline being of export specification. It was sold to the several concerns engaged in supplying gasoline to the European countries.

That left 40 per cent to be distributed for domestic use. Some of the gasoline distributed in this country was of export specification, as the concern has customers, who demand this grade. There are three grades of gasoline made for domestic use, 68-70 gravity; 64-66 gravity; and 60-62 gravity.

The two first grades are sold chiefly to filling station owners and jobbers in the States bordering on Canada. The 60-62 gravity gasoline is sold to customers around Wichita Falls.

Demand for high gravity gasolines in the district below Canada was found by investigation. One reason for its existence is cold weather. But the consumption of gasoline of this grade is throughout the year.

All Year Long

In all of its sales, the Orient policy is to select customers whose demand will be continuous throughout a year. Seasons may influence the amount of products required. But no customer is wanted, if his demand is for only part of a year.

The Orient company controls a string of filling stations west of Chicago, where gasoline of high gravity is sold. Part of its domestic outlet goes through these stations.

"The jobber or filling station owner who buys these high gravity gasolines," said Mr. Davis, "is the best customer a refiner can have. This type of customer is selling the product to a select trade. Consequently he does not buy this product on a price basis solely. He wants a quality product, for he knows he has automobile owners who will pay for a quality product. Often the filling station prices on these grades of gasoline is six cents above the filling station price on Navy gasoline. Frequently the refinery can get three cents in excess of the price of Navy gasoline."

But the experience of the Orient concern is that the selling of products of this class is not faced with fluctuations similar to those in the case of U. S. Motor gasoline. Prices for the higher grades move up and down but the changes are not sudden. It is the sudden changing of prices on U. S. Motor gasoline that makes for variations from prices of higher gravity gasolines, with this company.

The experience of the Orient Petroleum Company is that the buyer of high gravity gasoline is a better customer from a credit standpoint. He sells the product for a premium price. The nature of his business stamps him as a high class merchant. His credit is the best.

No Sales Manager

This class of customer is easier to hold than any other, in the experience of the Orient company. The class of customers demands two conditions. He wants the product to meet his specifications. He wants prompt shipment. These are plant problems, rather than sales problems. Both are met in the Orient plant.

As for selling, the Orient Petroleum Company has no sales manager, or sales department. Mr. Davis, who is vice-president and counsel, attends to what selling is demanded.

The sales policy of the company is to

get contracts over a year for two-thirds of the plant output. The remainder is sold on the spot market. Brokers are used for selling part of the third of the plant output not under contract. Two brokering concerns sell for the Orient company, frequently. The Orient does not fight shy of broker selling. It does demand that brokers ordering gasolines and naphthas be of the class of merchants similar to the regular jobber and filling station customers. This applies to business standing and credit rating.

The Orient plant is equipped for turning out the special products its market demands. The distillation equipment consists of one pipe still, four shell stills and a cleanup still. Four towers in tandem hookup, allow five streams to be taken off the pipe still. Two grades of gasoline and three of naphtha come off this still.

Expert Workers

Gas oil is taken off the shell stills, this being the last overhead cut.

Much of the equipment has been designed in the plant to meet special needs.

Neither the plant nor the organization of the Orient Petroleum Company is large.

"But every man having supervision over any finishing work is an expert," Davis explained. "Men do not necessarily come to the plant as experts. Most of them have learned there how to perform their duties as the company demands. After a few months of employment, if a man does not show aptitude for becoming an expert, we let him go, so he can find work where his abilities will not hinder progress."

The whole record of the Orient Petroleum Company is an instance of where a concern has turned off the beaten path and found a road that is less rough, and beset with fewer detours.

Acid-Resisting Coatings for Wood Surfacing

By H. L. Kauffman

Consulting Petroleum Chemist, Denver Colo.

THE importance of painting steel rundown and storage tanks and all iron or steel structural work in a refinery is a fact appreciated by all refinery executives. The proper grade of paint not only protects such metal surfaces from the corrosive fumes about a refinery and the weathering influences of nature, but, in the case of oil tanks in which volatile liquids are stored, the proper paint will also reduce to a minimum losses by evaporation in such tanks.

In addition to the painting of metal surfaces, another problem encountered by plant foremen and superintendents is to find the best acid-resisting coating for wood surfaces, especially where such surfaces are exposed to sulphuric acid fumes. Such conditions are encountered in and around agitators—more so, lubricating oil agitators—and even to a greater extent in and around acid recovery plants, with which nearly all refineries manufacturing lubricating oils, and hence using large quantities of sulphuric acid, are now equipped.

A number of years ago the writer had occasion to make a series of tests with various acid-resisting coatings in an effort to ascertain the best coating, either when used alone or in combination with others, for yellow pine lumber. At the particular refinery, in the laboratory of which this experimental work was conducted, a new acid-pan house was being constructed. As the wooden members of this building were to be made of yellow pine, it was desired to treat this wood with some coating of an acid-resisting nature.

This article will summarize, briefly, the results of the laboratory experimental tests made with fifteen different coatings, both singly and in combination, in finding out which coating would be most suitable.

Procedure

Yellow pine test specimens, 3½x3½x3½ inches in size, were prepared in the carpenter shop to be used in making these comparative tests. It might be emphasized again, at this point, that it was not expected to find an absoultely acid-resisting coating, but merely one in which the action of the acid fumes on the yellow pine would be retarded to a minimum.

Coatings Applied

The blocks were then treated in the refinery paint shop with a number of different coatings. The nature of the coatings given these test blocks, and the number by which each block thereafter was designated, is shown below.

Block Nos. 1 and 2.—Campbell's Gas-Proof paint and "paraffin solution No. 60" (a solution of 60 per cent paraffin wax and 40 per cent painter's naphtha). Dip coat.

Block Nos. 3 and 4.—Campbell's Gas-Proof paint and "paraffin solution No. 35" (a solution of 35 per cent paraffin wax and 65 per cent painter's naphtha). Dip coat.

Block Nos. 5 and 6.—Campbell's Gas-Proof paint, without any paraffin coating.

Block Nos. 7 and 8.—Roofing cement and rosin, with a dip coat of "No. 60 paraffin solution."

Block No. 9.—Roofing cement and rosin, with a dip coat of "No. 35 paraffin solution."

Block No. 10.—Roofing cement and rosin, without any paraffin coating.

Block Nos. 11 and 12.—Asphalt, naphtha and "hippo oil," with a dip coat of "No. 60 paraffin solution."

Block No. 13.—Asphalt, naphtha and "hippo oil," with a dip coat of "No. 35 paraffin solution."

Block No. 14.—Asphalt, naphtha and "hippo oil" without any paraffin solution.

Block No. 15.—One coat of "Stick-tite."

Block No. 16.—One brush coat of "No. 60 paraffin solution."

Block Nos. 17 and 18.—Dip coat of "No. 60 paraffin solution."

Block Nos. 19 and 20.—Dip coat of "No. 35 paraffin solution."

Block No. 21.—Brush coat of "No. 35 paraffin solution."

Block Nos. 22 and 23.—Plain, yellow pine blocks to which no coating whatsoever had been applied.

The "No. 60 paraffin solution" was applied by heating the solution to 150 degrees F. and then dipping the blocks therein.

Laboratory Tests

Lead-lined pans were obtained and then filled with dilute sulphuric acid. This acid was a mixture of 50 per cent water and 50 per cent 66 degree sulphuric acid. Dilute acid was used, because it was thought that by so doing more comparable results would be obtained.

All the blocks were immersed in the acid at the same time, and the effect of the acid on them noted. No attempt was made to observe the time of the reaction of the acid on the different coatings. Instead, when nearly all blocks had been attacked to a greater or lesser extent by the acid, all of them were removed from the acid bath, after which they were washed with water and dried, and the effect of the acid on the different blocks then carefully noted.

Results

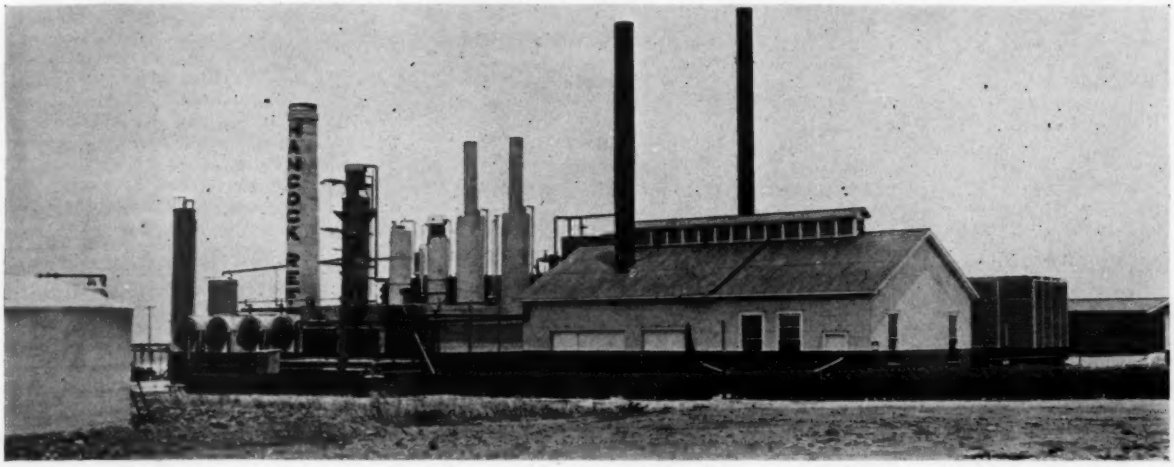
Block No. 1, to which had been applied Campbell's Gas-Proof paint and a dip coat of "No. 60 paraffin solution," was least attacked by the sulphuric acid.

Block No. 11, to which had been applied asphalt, naphtha and "hippo oil" with a dip coat of "No. 60 paraffin solution," was next best in withstanding the action of the 66 degree acid.

Campbell's Gas-Proof paint and a dip coat of "No. 60 paraffin solution," accordingly, was applied to all the yellow pine lumber used in building the acid-pan house at the particuar refinery at which these comparative tests were conducted.

Adding Still

Amarillo, Texas.—The Amarillo Refining Company is adding a pipe still to its skimming plant, located at Amarillo, thereby increasing the daily capacity of this plant to 6000 barrels. It is operating on crude purchased from Carson-Hutchinson County operators, and delivered via pipe line direct to the plant by the Pantex Pipe Line Company.



At the Hancock Refining Company's plant at Long Beach a painter is a member of the regular force.

In California They Yield the Paint Brush Constantly

Tom, the boilerman, says sweep, polish and paint are the password on the West Coast

By George Reid

TOM is a boilerman in the employ of one of the large refining organizations in the Los Angeles Basin.

"Brother," said Tom recently, "I've been with this company three years now, and during that time I've worn out four paint brushes, 22 brooms, used bales of rags, and I've polished that brass work until nothing remains but a husk. Other than steam, this company requires nothing but shinin' pots and pumps. If you find a spot of dust, dirt, oil, grease or rust in this building, and report me, I'll be returning to Texas in three days."

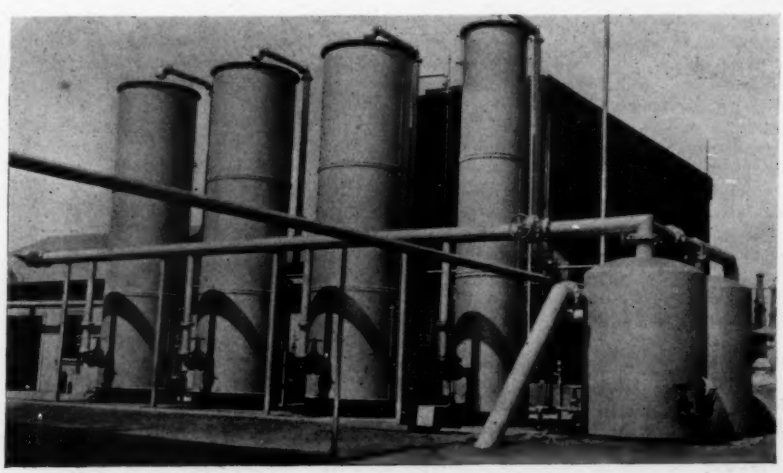
Tom's version is about correct as far as the usual attitude of the California plant operator is concerned, and if, and when, Tom returns to Texas, or elsewhere, it is quite likely that he will observe the same conditions existing in the petroleum industry as prevails in California. For, not only have the California operating companies discovered the unequivocal truth in the motto, "Save the surface and you save all," but refiners and gasoline manufacturers have come to realize that surfaces of steel, iron, concrete and wood must be protected against rust, corrosion and deterioration.

The day of slovenliness and carelessness in the handling of expensive equipment, buildings and structures peculiar to the petroleum industry, has passed and now the properties and holdings of the progressive gasoline manufacturer in either branch of the industry are in most instances decorative in effect; bright and cleanly painted—often an individual company color scheme is carried out in all its owned, leased or occupied territory, from flowing well to filling station.

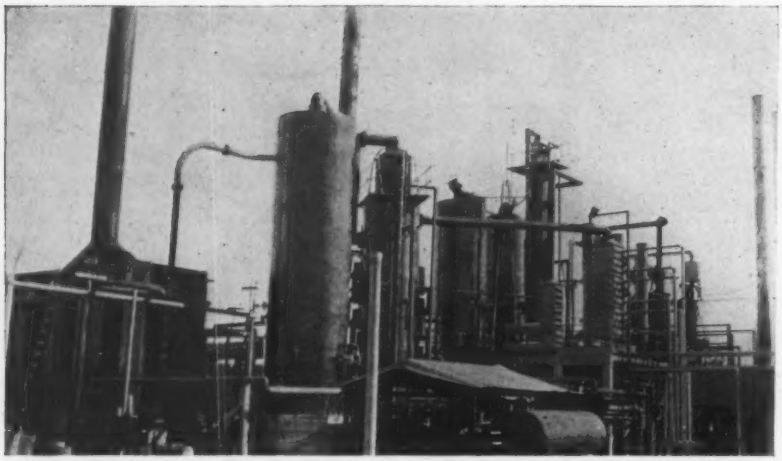
The California operators of refineries and natural gasoline plants follow the findings of the Government's Bureau of Mines, and Standards, in extensively applying light colored paints to tanks and equipment under low temperature conditions. This practice, however, will be discussed later.

Color Schemes Followed

The color schemes of the majority of the companies are employed even more extensively, in so far as public observation is concerned, and so are used for advertising purposes. Some of the color effects, which, as previously mentioned, are carried out in detail from the very wells producing oil, through the plants, warehouse, distributing stations, to the corner service station, are striking in their appearance, embracing practically all the colors in the scale and many combinations of two or more colors. Such paint work is primarily applied as protective coatings, and secondarily employed as a part of the company's general advertising program. This policy of employing the company colors for extensive advertising purposes carries with it certain advantages; for the use of certain paints in advertising work makes it positively necessary that the paints be renewed often for the sake of appearance before the public, and in this manner the equipment is usually main-



Aluminum paint is used exclusively by the California Gasoline Corporation



Black, white and Aluminum paints make a neat combination at the Jameson Oil Company, Los Angeles

tained in first class condition all of the time—rusting and corrosion being precluded by this policy of keeping buildings and equipment continually bright.

Paints for all purposes are composed of a number of various chemicals. The old familiar "white lead and oil" has given way to many compounds of different formulas, which are, in fact, highly specialized coatings that have been developed by the paint manufacturing companies, many of them especially for the petroleum industry. The large paint companies have been working in research for years, in conjunction with the Bureau of Standards, Bureau of Mines, and many large petroleum organizations in a cordinate effort to produce materials satisfactory to the needs of the petroleum and allied industries.

It is said by some authorities that a good paint must consist of at least three ingredients. An opaque pigment or body, having great capacity for reflecting light, and consequently great capacity for covering up and hiding the surface on which it is spread. The best substances for this purpose are basic lead carbonate, basic lead sulphate and zinc oxide. Then, an inert filler or extender, such as barium sulphate, chalk or china clay. Such a substance in itself has no great covering power, but it may be added to the main pigment in small proportion to prevent the latter from being spread out too thin, and in some cases to make it cling better to the surface on which it is applied. Then a vehicle or medium—a drying oil. The pigment and filler are incorporated in this by means of special grinding machinery, that reduces the particles to the utmost possible degree of subdivision, and produces a homogeneous, viscous mass needing only to be thinned with a small amount of turpentine, boiled linseed oil, or naphtha, to be ready for use. The vehicle must dry by oxidation within a reasonable time, and must be free from more than traces of acid. Pure linseed oil is best, though the admixture of a small amount of turpentine is permitted.

In addition to those three constituents a colored pigment needs to be added if the paint is to be of any other shade than white. Among the opaque pigments, each has some special virtues. Zinc oxide, for instance, is pure white, is non-poisonous, and will not darken when exposed to air containing hydrogen sulphide (zinc sulphide is also white.) But zinc oxide paints have the disadvantage of drying in films that tend to blister and peel off. The white lead paints usually have the opposite failing, tending to become chalky, and hence easily rubbed off, after long exposure to air. Another disadvantage of this chalky texture is that it hinders the removal of dirt by sponging. Zinc oxide paints are said to be distinctly inferior to white lead paints in covering power. Because of its cheapness, however, zinc oxide has been used to a large extent as an adulterant of white lead.

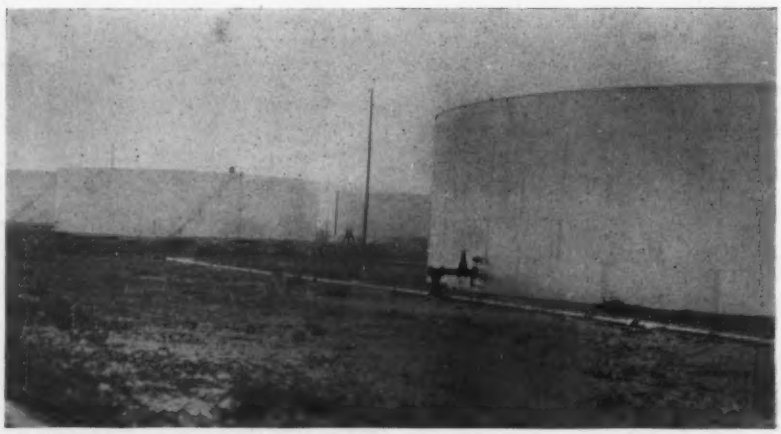
Place of Oils

Oils, used for paints and similar coatings are technically known as drying oils. This is a misnomer, as they do not dry by loss of moisture, but by oxidizing on exposure to air. On taking up oxygen they become thick and finally become solid and lose their sticky or oily feel. There are quite a number of such oils, as walnut oil, poppy-seed oil, soya-bean oil, Chinese-wood oil, etc., but for most purposes linseed oil is considered as best. The first two oils mentioned are used to some extent in artists' colors, and Chinese-wood oil is used in some varnishes and oil stains after a heat treatment toughens it. Chemists measure the drying properties of oils by their ability to absorb iodine, as iodine acts somewhat like oxygen in uniting with some substances. This iodine absorption is measured, and is called the iodine figure of the oil. The following table gives iodine figures of some well known oils.

Beeswax	8-11
Cocoanut oil	7-9
Butter fat	26-35
Oleomargerine	55
Tallow	36-40
Lard	57-63
Olive Oil	81-85
Cottonseed oil	117-122
Linseed Oil	175-190

The iodine figure of linseed oil is very characteristic and the test is always applied to this oil. Pure, fresh linseed oil does not oxidize very rapidly and if it were used alone in paint it would not set fast enough, so driers are put in which induce quick setting, say in 12 to 24 hours. These driers contain compounds of lead or manganese, for example, and act catalytically—or induce action without being apparently changed themselves, So called boiled oils have had the drying treatment applied to them.

A further study of paint coatings and the chemicals composing such paints, as conducted by the institute of paint and varnish research, Washington, D. C., under the direction of Dr. H. A. Gardner, discloses certain valuable information relative to the rust inhibitive qualities of painting materials. For example: "Chromic compounds, such as basic lead chromate, normal lead chromate, and zinc chromate will prevent the corrosion of iron. And—basic pigments of the following types—litharge, red lead, blue lead, a basic sulphate, white lead and zinc oxide, will inhibit or retard the corrosion of iron. Also very durable protective films are produced by so-called neutral or inert pigments—iron oxide, for example—which do not excite corrosion, when used with linseed oil. Black, brown, and red oxides of iron, china clay, silica talc, and barium



The spray gun is used for painting storage tanks of Julian Petroleum Corporation, Julian City, California

sulfate are included among such pigments. Then substances that form a galvanic couple with steel, in the presence of moisture, cause rapid corrosion. Carbon pigments act in this manner. They should be used only as components of finishing coats on steel surfaces, after such surfaces are insulated by a coat of basic or chromate pigments paint, and when thus employed with linseed oil they form very durable and water resistant coatings."

Light Colors Best

The investigations along the lines of producing paints which are rust preventive have more or less paralleled the research dealing with the values of colors, when colored paints are employed as coatings for tanks containing volatile oils. The paint chemist, through his research, has given the industry valuable data relative to the materials embodied in and comprising the protective coatings, and has developed special paints to specification for use on equipment where high temperatures prevail and where temperatures are subject to abrupt charges. Further, paints are provided which are especially resistant to acids, alkali, salts and corrosive gases. During the last few years much attention has been given to the color of these various coatings, for on volatile oil containers the heat reflection or absorbing qualities of a finishing paint are found to be of great importance.

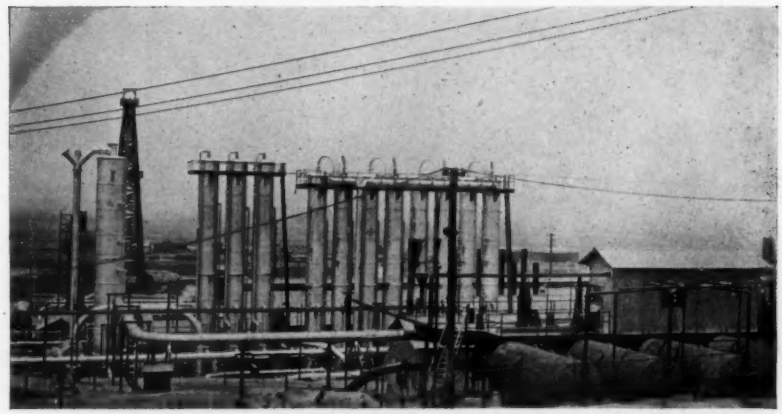
Investigations of the Bureau of Mines have proven conclusively the inadvisability of employing dark or black paints as a coating for crude oil storage tanks or tanks containing lighter oils. Tests of various types of crude oil will naturally vary with the grade or volatility of the crude itself—but the results of a series of tests upon tanks of different colors containing the same type or grade of crude offer conclusive evidence as to the value of the lighter color coatings. For example, the Bureau of Mines reports the following findings:

Time—One year.

Tank color	Loss in Per cent Loss	Gravity Deg. A.P.I.
Black	1.24	.6
Red	1.14	.5
Gray	.99	.3
Aluminum	.83	.2

Black, red, gray, white and aluminum are generally applied to gasoline and crude storage tanks, with aluminum rapidly displacing all other colors on the West Coast. Evaporation losses are known to be minimized by the application of the lighter shades, a reduction in losses of 1½, 2½, to 3% is claimed by some companies. Numerous tests have been run on the West Coast to definitely establish this preference, with the result that aluminum paint is leading in favor, with pink, gray and blue following.

In the choice of paints a black graphite, or red iron-oxide base pigment of excellent quality and permanent in color when exposed to sulphur gases, can be easily obtained from any reputable paint manufacturer. On the other hand it is a little difficult to secure a white or gray paint that will stand up under severe working conditions without blackening. For this reason a pure white paint is not usually employed, but rather a grey, shading off from off-white to lead color, according to the severity of the conditions. While zinc oxide is the principle pigment in most light colored paint prepared to withstand sulphur gases, an all zinc base is not always satisfactory and a certain amount of basic lead sulphate is generally incorporated. If this latter lead compound contains a trace of oxide, or carbonate of lead the paint will darken when exposed to the action of gases containing hydrogen sulphide, as usually found in refinery operations. It appears that under usual conditions a reducing action takes place so that paint containing lead in any form will gradually darken. Such instances require a pure zinc base paint or the adoption of some dark color pigment. Zinc oxide makes an ideal permanent white base where there is exposure to sulphur gases since zinc sulphide, when formed under working conditions, is itself white, and no darkening in color results.



Natural Gasoline Plant of the Shell Company at Long Beach. Aluminum paint is used extensively here

Selecting Aluminum

However, under usual working conditions, it has been found that a very high grade aluminum paint, though about equal in efficiency in preventing absorption of heat as pure white or very light tints, is not affected by hydrogen sulphide fumes. For this reason it is preferred over light tints—which as previously stated will usually darken quickly if they contain any lead oxide or carbonate.

For the reasons as outlined above, the refiners and natural gasoline manufacturers on the West Coast are extensively employing the aluminum paints as a protective coating for their equipment. Usually, all run down tanks, run down lines, storage tanks, many towers or dephlegmators, condenser boxes, and condensers of Southwestern and Braun types, are often painted in aluminum. In the gasoline plant the gasoline tanks, gas lines, and absorbers are likewise coated with this same material. Aside from the benefits derived from this type of paint as previously discussed, the advantages of cleanliness and brightness are secured, and as mentioned early in this discussion, the California operator takes keen interest in the appearance of his property.

Insulated equipment is usually given a protective coating of either white or black paint, depending perhaps, upon the inclination of the individual operator. Evaporators, hot oil transfer lines, insulated stills, etc., are generally colored black, with brick still and boiler settings brightly red. Red is used universally as a means of coloring fire fighting equipment. All hand extinguishers and supporting racks, all small buildings housing the small two wheeled type of fire engine, all water hydrants, are bright, flashing red. The usual Foamite system installation is generally red in complete detail, the house containing the chemicals pump, the chemical tanks, the lines conveying chemicals to individual tanks, valves, and the chemicals inlet equipment at the tank tops, are red and kept freshly colored. Even the sand barrels and shovels, which, by the way, are never moved except in the event of fire, are coated red. And it may be stated, that this occurence of red at frequent intervals throughout the refinery or natural gasoline plant yard, detracts nothing from the beauty and well kept appearance of the property.

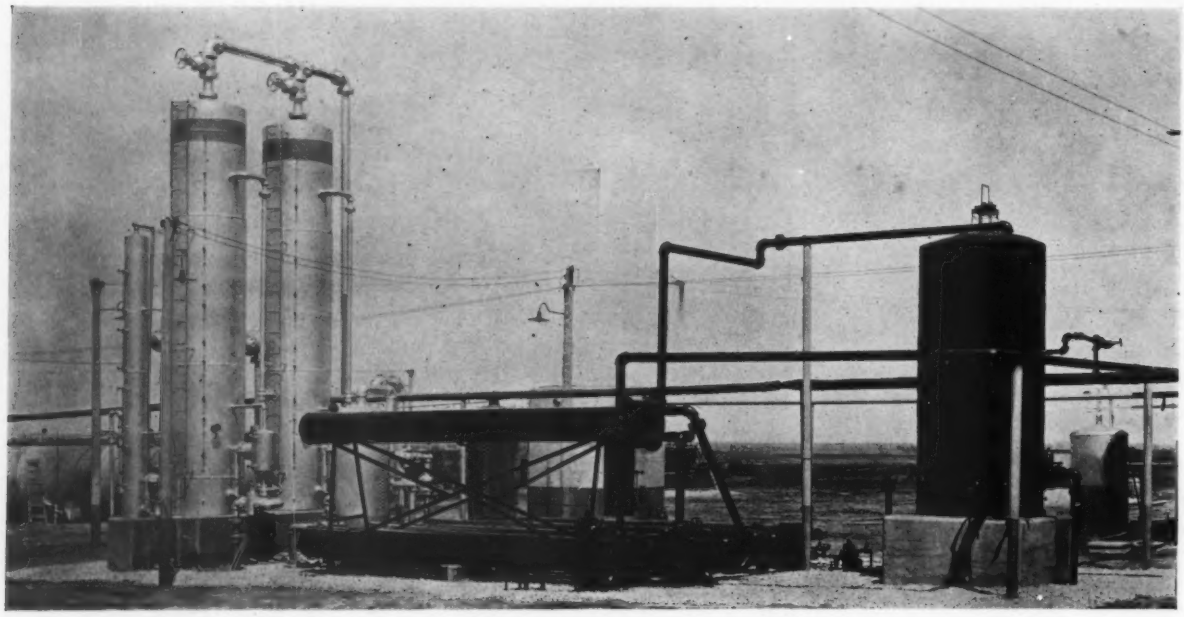
It is the boast of the progressive plant operator in California that plant equipment, tanks, houses, as well as service stations and motor vehicles are never in need of paint—but that they are painted. And the property that is kept freshly painted is almost invariably freshly clean and sparkling—with the result that rusting or corrosion of equipment is entirely precluded, and better efficiency and economy is surely obtained.

Superintendents to Meet With Technical Committee

Tulsa, Oklahoma. — The technical committee of the Western Petroleum Refiners Association will meet July 15 at Ponca City, where with plant superintendents of Oklahoma and Kansas plants, they will inspect the refineries of the Marland Refining Company and the Empire Refineries, Inc.

The invitation to plant superintendents is a departure in proceedings of this committee. No technical program has been arranged. There is a docket for the committee to follow in its meeting.

The invitation to plant superintendents is a move to promote better acquaintance between technical and operating men of the Mid-Continent refining industry.



Pure Oil Company's Natural Gasoline Plant, Mehan Field, near Mehan, Oklahoma, painted with portable equipment

Pure Oil Adopts Portable Paint Units

Speed in moving and speed in painting bring saving through use of trucks

By Roye Munsell
Staff Representative

THE important part which paint plays as a factor in the operation and maintenance of the refinery and the natural gasoline plant is no longer disregarded, not totally at least, by any concern.

The Pure Oil Company, one of the pioneers among those having a more or less well defined policy of surface finishing, has a separate department for handling its paint work.

Three trucks are maintained at Tulsa to cover the surrounding properties of the Pure Oil Company and a full crew of painters is attached to each truck.

Claude Dyer, an experienced paint man, is in charge of the work and travels about watching it closely.

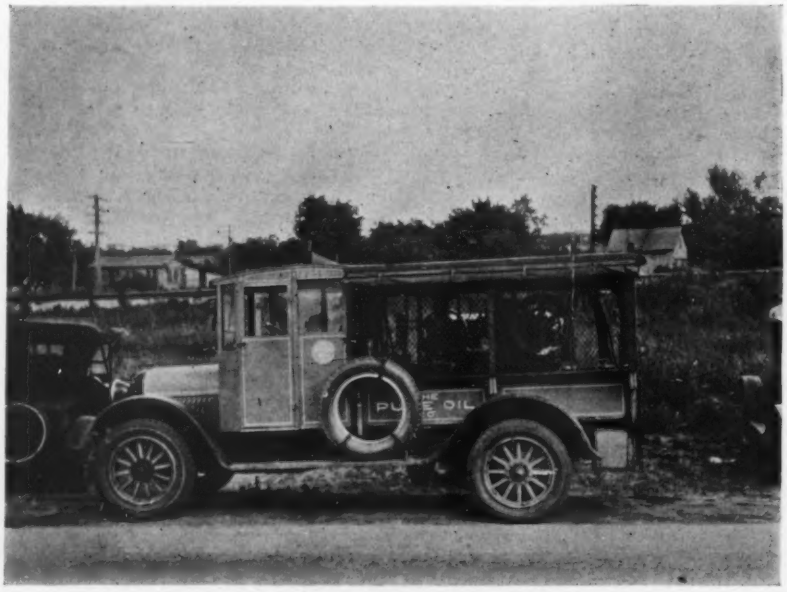
It was said a while ago that a crew of painters is attached to each truck. In the event that men are to be used for cleaning surfaces and such work, the force is supplemented by unskilled or semi-skilled labor which can be readily secured locally when and where needed.

Spray Saves Time

The Pure Oil Company is using the spray brush for virtually all of the work on the larger jobs. The painting department, as a rule, handles only such jobs. The smaller jobs around a plant can be done, it is evident, most practically by the operators themselves.

The company has found that not only can a job be done in less time with spray equipment, but with a material saving, in not a few cases, in the amount of paint used. According to Dyer, one man with a spray outfit can do a given piece of work in the same time that it would take several men using hand brushes. In most instances, moreover, after the job is finished with a spray gun it will be much better than would be done with hand brushes.

A striking example of what is being accomplished with the spray brush is the instance where enough was saved both in time and paint in painting a



Truck used by the Pure Oil Company's painting department

shingled roof of a company house to finish the outside walls of the house.

Even trimming is done with the air brush. Most anything, one of the painters explained, can be used as a shield in trimming with an air brush.

In very cold weather, however, a spray brush, it has been found, cannot be used very well because of the effect which the low temperature tends to have on the paint being sprayed on the cold surface. Using either a hand or an air brush, there is a limit to the temperature condition under which the paint may be practically applied. The limit is only slightly higher with a spray brush.

Portable Equipment

The type of truck used by the painting department of the Pure Oil Company is shown in Fig. No. 1. They are Reo Speed Wagons with screen bodies.

Air compressor units consisting of Fairbanks-Morse gasoline engines and Curtis compressor are placed on the trucks. These units were originally mounted on small steel wheels. The wheels were removed and the compressing machine permanently secured to the floor of the truck. Plenty of room is left in the truck to stow hose, paint pots and materials. Binks spray equipment is used.

On the roof of the trucks are placed iron brackets for carrying ladders, scaffolding and other pieces of that nature.

The trucks can travel at passenger car speeds and a minimum of time is required to move from one place to another.

One instance with which the present writer is familiar, a truck in the same day quit one job, travelled more than 100 miles and started on another, losing only a few hours painting time in making the change.

There is a sort of "knack" to moving and by having an organization that is literally on wheels, it can be expected that they will take a minimum of time quitting one job, gathering up their materials, moving to another place, and getting onto another job.

Standard Colors Used

Standard colors are used on practically all paint jobs. In the case of natural gasoline plants where aluminum is now employed on most of the outside equipment, such as bubble towers, tanks, etc., the same paint is being used on the plant buildings.

Much has been said about the use of aluminum paint as a means of reducing evaporation losses. Nothing need be added here. The Pure Oil Company is using large amounts of that paint for this purpose. They are also using it under some conditions as an undercoat on wood surfaces. It is especially desirable, according to Dyer, in cases where a finish of great hiding power is required.

The Pure Oil Company paints virtually all equipment and buildings when they are erected. Repainting is done at varying intervals. There is no set time rule to govern it, the main consideration being the requirements in the particular case.

The gasoline engine driven compressor is placed in a screen body, where is also stowed the rubber hose, paint pots, etc.

Under conditions which accelerate the break down of the paint film, such as excessive heat, exposure to steam and deteriorative gases, the time interval between paintings are apt to be rather shorter.

The painting program of the Pure Oil Company may in a word or two be characterized as a continuous program. Painting is not done just now and then and in a haphazard, inconsistent manner, but rather all the time—continuously.

Natural Gasoline Association Begins Campaign

Tulsa, Okla.—With the retention of Dr. E. H. Leslie and Dr. G. G. Brown, professors of chemical engineering at the University of Michigan, for research work, the Association of Natural Gasoline Manufacturers is now ready to begin its first year of educational activity.

Announcement of the selection of the two Michigan professors followed a visit of Dr. Brown to Tulsa, where he met with the association's educational committee. The contract has been drawn for retention of the services of the two men, as well as the time of several students working for higher university degrees, for one one year from July 1.

This contract provides for a complete program of scientific research in the field of natural gasoline.

Combustion First

The first work will be done in the field of combustion, with particular emphasis on the anti-knock qualities of natural gasoline, followed by general investigations on engine performance, which will include starting, acceleration, power development, mileage, fuel consumption and crank case dilution.

In addtion to the laboratory work and actual tests in automobile engines, Dr. Brown will appear July 16 before the Michigan Independent Oil Men's Association at Mackinac Island, where he will be heard on the subject, "The Value of Natural Gasoline as a Motor Fuel."

The purpose in retaining the two men for scientific investigation is part of the broader program of acquainting the whole petroleum industry with the qualities of natural gasoline. Scientific work will be conducted largely at Ann Arbor, Mich.

When investigations bring to light striking qualities of natural gasoline, it is the purpose of the association to carry these messages before other branches of the petroleum industry. One means will be the appearance of one of the investigators before associations and other representative bodies within the industry.

Advertising Planned

Along with this it is the intention to present these findings in the several trade publications connected with the industry. Systematic advertising campaigns are to be carried through, as fast as material is developed in the scientific studies.

Efforts to employ the two Michigan professors began shortly after their joint paper on natural gasoline was presented before the fifth annual convention of the association in Tulsa last May. The paper was presented by Dr. Brown and is car-

Painting Tank Cars Inside

American Refining Company finds coatings for interior protection at reasonable cost

By Ralph E. Goode

IN the service of refiners of crude petroleum are hundreds of tank cars used in the shipment of gasoline and crude oil products to various points of distribution throughout the nation. These cars leased or owned by the refiner bear the company's name and trade mark and serve to advertise the company in a forceful way. The refiner depends for a very large per cent of his business on gasoline shipments to distant points and the task of keeping these tank cars up to the requirements of rail and delivery service is no small one. They must be acceptable mechanically to the railroad company and must be frequently repainted inside and out, and other adjustments made upon them.

The tank car department of a refinery is an important unit and a very interesting part of the plant. There is where the painting and general machine shop work is done. A tank car in service coming in for loading is placed on the plant's private track before going to the loading rack and is inspected for signs of bad order. If during the inspection the car is not found in good condition a bad order tag is attached to the dome cover and it is then placed in position for the necessary repairs.

The tank car having the name of the company painted on the sides, the car initial and capacity in gallons may have had this information worn off by the elements and this must be replaced.

Going Inside

The inside of the car although not exposed to weather or other outside forces has much more powerful elements to combat being exposed to the various compositions of hydro-carbons and the solvent effect of gasoline and naphtha. Most paints being soluble in gasoline and light oils soon flake off or dissolve where they are used in painting the inside of tank cars leaving the metal exposed to corrosion and rust. Particles of iron oxide are left which tend to throw the gasoline "off" color and in some instances affects the volatility of the product.

Paint for the inside of a tank car must of necessity be the very best product for the particular work obtainable. Pure red lead has long held a high reputation as a paint for the protective coating of iron and steel. Graphite is also used in a great many instances, but is not suitable for work connected with tank car painting.

Paints from the chemical point of view may be considered as consisting of two parts; the vehicle, and the pigment. The vehicle may consist entirely of linseed oil, which is frequently the case with individual paste pigments. Sometimes, in the case of mixed paints, it also contains a certain amount of driers and of a thinner which may be either mineral spirits or turpentine; and in the case of enamels and paints that have a high gloss finish the vehicle may contain varnish or varnish gums which is the case with paints used in the coating of the inside of tank cars.

A paint pigment may be a simple chemical compound such as zinc oxide, or it can be a mixture of a number of substances. For resisting the solvent actions of gasoline and naphthas a red lead paint has been found to be most suitable and is used for the protection it affords and not as a tinting pigment. Red lead and organe mineral used in paint mixtures in the pure state are oxides of lead and are mixtures of comounds containing varying proportions of lead oxide and lead dioxide. A number of paint manufacturers are at the present time manufacturing special paints for the coating of the inside of tank cars that are highly resistive to the solvent action of gasoline.

Two Paints Used

The American Refining Company has used a tank car paint made by the Eclipse Paint Manufacturing Company and the American Red Lead Paint manufactured by the Sewell Paint Company in inside tank car painting and with good results. The paint in one instance has not had to be replaced in two years whereas six months was the usual length of time and service other paints had given. The essential compositions of these paints are such as to form a special resistance to the actions of light oils. The paints have a special composition of varnish shellac gum ground in castor oil and dries with a high gloss finish which is impervious to the solvent actions of gasoline and naphthas.

In a laboratory test acids had little or no effect on the paint except in the case of acetic acid.

In painting the inside of tank cars great care is exercised so that the walls are absolutely clean and dry before the paint is applied. The cars are washed with kerosene until all foreign substances are removed and then are wiped dry with waste. Special care is taken about outlet caps and rivets as occumulation of sediment is more likely about these parts.

Safety Practiced

Saftety measures are employed in the cleaning and painting of the inside of these cars as there is some danger of axphyxiation during cleaning and of lead poisoning during painting. Two men are generally placed in the car wearing oxygen helmets while a third is left in charge of the air pump and hose. These oxygen helmets have a head piece which slips over the head resting on the shoulders with a breather connected from the back with the air hose going to the pump.

Immediately following the war and for some time after a large number of gas masks not suitable for refinery work were placed on the market. These masks were valuable for the particular work of war but were not designed for use in the case of carbon monoxide and the gases of hydrocarbons. The air is fed from the pump in a steady even stream with the oxygen apparatus and the painter is assured of as pure an element as he would breathe were he outside. Sometimes however proper precautions are not taken even with the oxygen apparatus. There was the case where the apparatus was loaned out and while there the short air hose on the head piece was disconnected and never replaced. It was not noticed when returned and was placed in use by the painter who was slightly overcome while at work.

Cost Low

The cost of painting tank cars varies somewhat due to handling conditions but with modern painting methods the cost will average in the case of an 8,500 gallon car, $15.00.

After a car has been cleaned and dried it is ready for the first coat of paint. The paint is reduced for the first application with 20 per cent of 188 proof wood alcohol and is applied with either a brush or paint gun operating with compressed air. The paint not being soluble in any substance except wood alcohol it is not desirbale to keep a large stock on hand. One barrel will suffice for the painting of ten cars without special economy being practiced. From an hour to one hour and a

(Continued on page 81)

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ried in this issue of The Refiner and Natural Gasoline Manufacturer.

Members of the educational committee of the Association of Natural Gasoline Manufacturers are D. E. Buchanan, Chestnut & Smith Corp., chairman; S. C. Carney, Roxana Petroleum Corp., G. G. Oberfell, Phillips Petroleum Corp., Lloyd F. Bayer, Tidal Refining Co., H. R. Johnson, Akin Gasoline Co., and A. V. Bourque, secretary-treasurer of the association.

Coincident with the inauguration of the educational campaign, a committee headed by H. A. Trower of the Phillips Petroleum Company was successful in efforts to raise money for the educational work. Part of the fund for defraying expense of the effort is yet to be raised, but sufficient has been accomplished to give every indication of its success.

Organization Essential to Fire Fighting Unit*

By Frank G. Benedict
Sinclair Refining Company

IN order to be a success a private fire brigade should be organized by the management and an active interest should be maintained by the management in its activities.

A permanent fire marshal or chief should be appointed. This man should be especially selected and should be one of good personality and more or less of an organizer, and preferably should already have a position of some authority about the plant. The fire marshal should be responsible for the proper maintenance and good working order of all fire fighting apparatus. He should see that the various hose crews are properly drilled and instructed in the handling of their equipment. It should be his duty to see that all fire extinguishers are kept fully charged and in good working order; that all hose reels, reel houses and hydrant houses are kept fully equipped; to oversee the proper replacing of fire apparatus after its use at a fire or drill; to test regularly the fire alarm system; to see that the foam solutions, if any, are properly mixed and kept efficient; to see that all water cut-offs and valves and fire steam valves are kept in good working order and that they are plainly marked; that roadways are not blocked or torn up for any considerable time; that no authorized connections are made to fire hydrants or unauthorized use made of fire apparatus, etc.

Many Crews Needed

As many hose crews should be appointed from the regular employees of the various departments as is deemed necessary to handle properly the apparatus on hand, and properly defend the plant in case of a fire. In the case of a refinery, where the operations are on a 24-hour basis there should be regularly appointed crews on each of the three shifts. Each hose crew should consist of six men and they should be designated and assigned as follows: one captain, two nozzlemen, two hosemen, and one plugman.

Each hose crew should be assigned certain apparatus and in case of a fire alarm, they should obtain that apparatus and no other.

Two Extra Crews

There should be two additional crews designated; one to be known as the mechanical crew and consisting of a captain, two pipefitters and an electrician. They should answer all fire alarms and should come equipped with the necessary tools of their trade. The other should be designated first aid crew and should consist of the first aid man, a crew captain and two crew men.

The first aid man should remain at the first aid station and there await orders from the fire marshal. The first aid man should make all calls to the outside for doctors, ambulances, etc.

The first aid crew should answer all fire alarms, carying first aid equipment and stretcher, and report immediately to the fire marshal.

Regular fire drills should be held. At first these drills should be announced in advance and it should be the duty of the fire marshal and crew captains to see that the men comprising the various crews are notified that drill is to be held and that they have had some instruction in their duties. A sufficient number of announced drills should be held so that the crews of each shift will have experienced one or two and after that the drills should be unannounced and should be held at irregular intervals of time.

1. Location of fire alarm boxes—The numbers and locations of the fire alarm boxes should be posted on the plant bulletin boards and all plant employes should memorize the location of each of these.

2. Immediately upon the sounding of the fire alarm, the pumper should start the fire pump and bring it up to full speed.

3. Immediately upon the sounding of the fire alarm, everyone who is using water from the fire mains or hydrants must shut off the hydrants and disconnect all hose from the hydrants.

Marshal In Command

4. The fire marshal should be in supreme command. He should go directly to the fire and take command, also get in touch with the foreman of the department in which the fire is located and should be advised by him as to conditions of stills, tanks, piping, wiring, etc.; extent of the fire and as to what has been done, etc. He should give orders to the captains of the hose crews as they arrive, directing them to hydrants, etc.

5. Operating foreman and crews in the department where the fire is located should remain on duty. They should use the hand extinguishers, turn on fire steam or foamite, start pumping out, etc. The operating foreman should report to the fire marshal upon his arrival and then take all orders from him.

6. The watchman at the main gate should call the superintendent, assistant superintendent, etc., if they are off duty, in the order in which they are posted on a list that should be placed near the 'phone in the watchman's office. He should keep a record of all employes entering and leaving the plant during the time of the fire and allow no strangers or unauthorized persons to enter or leave the plant during the time of the fire.

7. Operating employes who hear the fire whistle at night should proceed immediately to the plant and report to the fire marshal.

8. All operating men not assigned to hose crews should remain on duty prepared to run or shut down as directed by the fire marshal.

9. If a fire gets beyond the control of the regular fire crews, the fire marshal should turn in a general alarm by pulling again the alarm box that was first pulled or by notifying the power house, the same as for the first alarm. The boiler house whistle should then sound the general alarm. Three distinct blasts should be sounded on the boiler house whistle, and this should be repeated three times.

10. When the general alarm is sounded, the watchman should immediately call the city fire department, and any men off duty who can be reached by telephone.

Report to Marshal

11. When the general alarm is sounded all employes not actually operating stills, pumps, etc., should immediately report to the fire marshal. Employes who fail to report to the plant when the general alarm is sounded, should be asked to explain to the superintendent why they did not. At night, a first alarm should be considered the same as a general alarm and all employes must report or explain why.

12. The fire marshal may shut down operating units and he should order stills, agitators, pumps, etc., to be shut down as he finds it necessary to protect property or to secure additional men for fire fighting, but he must leave at least one man at each unit he shuts down—this for safety. The fire marshal is in supreme command of the entire plant during the time of fire, and all his orders must be obeyed.

13. Certain operators whose duties are considered essential should remain at their posts of duty in any emergency as long as it is safely possible for them to do so or until relieved. These operators should be designated by the fire marshal and are the water pumpman, boiler house man, watchman, etc.

14. When the fire is under control and no more help is needed, the fire marshal should order the boiler house to sound the recall.

15. The boiler house whistle should sound the recall by blowing one long blast. All men not already on fire duty or arrived at the plant should turn back.

Keep Pumps Operating

16. The fire marshal should remain on

*Bulletin issued by the Association of Fire Marshals of the National Petroleum Association.

duty after the recall is sounded and until the fire is entirely out. When the fire is out the fire marshal should see that the fire fighting apparatus is properly taken care of and put away.

17. The fire marshal should order the fire pumps shut off. The fire pumps should not be shut off at the sound of the recall, they should not be shut off until ordered so by the fire marshal.

18. Immediately after the fire, the fire marshal should make out a full, detailed written report and should hand same to the superintendent.

19. General rules for fighting refinery fires:

Obey absolutely the fire marshal. Keep cool.

Crews, obey your captains. A fire brigade must work together like an army. Do not start off on your own hook. Do not attempt to give orders unless you are a captain or the fire marshal.

Always remember safety first. A fire is an unusually dangerous occurrence, so be unusually careful. Men are worth more than property. This the company never forgets, and does not want you to.

Keep track of all your men. If you are a foreman and have a gang near the fire, be sure first that all your men are safe. Report missing ones to the fire marshal.

Await the Order

Crew captains report to the fire marshal immediately on arrival, get orders from him and obey him. Get your hose strung out and in readiness, but do not turn on the water until ordered to do so by the fire marshal.

Do not turn water on hot tar lines or hot brick or concrete walls.

Do not turn water on live wires or electrical apparatus.

Do not use foamite or soda and acid tip-up extinguishers on electrical apparatus.

Use only hand pump type (tetrachloride) extinguishers on electrical apparatus.

Try to prevent surrounding units and property from catching fire just as vigorously as you are trying to put out this fire.

Look out for explosions of oxygen cylinders, or oil drums and if any are in or near the fire play streams of water on them in an effort to keep them cool.

Spell off nozzlemen and hosemen at frequent intervals, especially if they are in wet, cold or difficult positions.

Relieve operating men from fire duty as quickly as possible and send them back to their regular work using laborers to take their places.

Use available shelter or construct shields and get as close to the fire as safety permits.

Direct hose streams at the base of the fire; if directed high up at the flames, it will have little effect.

Study the plant fire maps that are posted in each cart house.

Study the fire rules at least enough to have a working knowledge of them.

Fire Map Good

A copy of the plant fire map should be posted in each cart house. This map should show all buildings, still batteries, tanks, dike walls, roadways, railroads, etc. It should show the location of all fire alarm boxes and fire hydrants, giving the numbers of same. It should show the location of telephones. The location of hose cart houses and hydrant houses should also be shown giving numbers of same and equipment in them. The location of the fire mains should be shown with all cut-offs, valves and pumps plainly marked. All fire steam connections and control valves should be plainly marked.

The fire whistle should sound the alarm. At the alarm of fire the men comprising the various hose crews should immediately run to the cart house assigned to them. The first two men to arrive at the cart house should get the doors open and hold them open until the cart is out. The next men to arrive should get the cart out into the clear.

Regular Positions

In running the cart to the fire, the men should take regular positions which are as follows: two nozzlemen in front pulling on the rope; two hosemen behind them pulling on the cart handle, and captain and plugman behind pushing on the cart.

The crew should run the cart toward the fire as directed by the captain.

Each crew should take orders only from its captain and the crew captains should take their orders only from the fire marshal who is in supreme command during the time of fire.

The plugman should open the tool box while running; also take out the hydrant wrench and the captain should take out two hose spanners.

If possible, when near the fire, the captain should run on ahead, report to the fire marshal and receive instructions from him as to which hydrant his crew should connect.

The crew should run the cart to the hydrant and come to a full stop long enough to allow the plugman to snub the hose by giving it one complete wrap around the hydrant. The cart should not be again started until the plugman has the hose effectively snubbed. The crew and the captain should then run on with the hose cart, allowing the hose to unreel, to their selected position near the fire.

The plugman should stand with one foot on the free-end of the hose and he should start opening the main hydrant valve with the hydrant wrench. As soon as this valve is fully opened, he should remove the caps from the hose connections. He should then unwrap the hose from around the hydrant and connect it to the plug then stand ready to open the plug gate valve.

The plugman should not open the gate valve until ordered to do so by his captain but should stand by his hydrant and not leave it unless relieved. He should also keep his eyes on his captain and be ready to obey signals.

The captain should stop the crew when they are in position and should see that enough slack is reeled out in order that the nozzle may be moved about.

Breaking the Hose

The hosemen should break the hose connection by straddling the hose facing each other, and unscrewing the coupling. (Couplings are usually made up hand-tight and spanner wrenches should not be necessary; the captain, however, should stand ready with the spanner wrenches in case they are needed.) The hosemen should drag the hose cart back and off to one side, out of the way.

The nozzlemen should connect the nozzle. One man should straddle the hose and the other screw the nozzle onto same. They should take positions on opposite sides of the nozzle with one hand holding onto the handgrip and the other about the nozzle near the tip.

One hoseman should take a position about three feet behind the nozzlemen and the other a position about four feet behind the first hoseman.

When his crew is ready the captain should report ready to the fire marshal. The fire marshal should then order the captain to turn the water on. This should not be done, however, until so ordered.

The captain should signal his plugman to turn the water on.

The hosemen should keep the hose straight behind the nozzlemen and close to the ground.

The crew should have practice in taking out a broken section of hose.

Removing Broken Section

The captain should mark a section of hose to be taken out of the line and he should then signal to the plugman to turn the water off.

The nozzlemen should run back to the end of the marked section nearest to the hydrant. Both men should straddle the hose facing each other, unscrew the coupling, drop the hose and then run back and resume their places at the nozzle.

The hosemen should run back to the end of the marked section farthest from the hydrant. They should straddle the hose facing each other, unscrew the coupling, drag the free end of the hose back toward the hydrant, again straddle the hose facing each other and connect it up. They should then resume their regular places. (The captain should stand ready with the spanner wrenches if they are needed.) As soon as the line is connected up he should signal the plugman to turn the water back on. When the drill is over, the captain should signal the plugman to turn the water off. The plugman should close the gate valve and the main hydrant valve. He should also disconnect the hose from the hydrant.

The captain and the plugman should drain the hose from the nozzle back toward the hydrant by raising it over their shoulders. Disconnect it near the middle, if necessary.

One hoseman should fold the end of the hose and fasten it between the bars of the reel, and should then guide the hose onto the reel.

The nozzlemen should pull the cart and wind up the hose.

The other hoseman should guide the cart.

The captain should see that the nozzle, wrenches, etc., are properly replaced and

that the hose cart is properly placed in the cart house.

Talk It Over

After the drill the fire marshal, crew captains, observers, plant officials, etc., should congregate at some convenient place and indulge in a free and open discussion and criticism of the fire drill just held. A written examination should be given, questions asked being those pertinent to what should be done in case of a fire at certain places, location of fire extinguishers, procedure in emergencies and questions pertaining to the fire rules, etc. The same set of questions should be used for each shift. This will tend to create some rivalry and also show whether or not the bulletin boards are being studied.

1. When you see a fire, immediately notify the head of the department where it is located as he is responsible.

Keep your head and do not get excited.

If the fire is at the stills, notify the stillman.

If the fire is at the agitators, notify the treater.

If the fire is in the car department, notify the foreman, and so forth.

But, if the man in charge is not around; or you think that delay will cause serious damage, turn in the alarm yourself.

2. If the fire is in a tank on the tank farm; or in an unoccupied building, turn in the alarm yourself.

3. Turn in a fire alarm by pulling down the lever of the alarm box nearest to the fire. Do not pull any other alarm box, as this would turn in a false alarm, or telephone the power house telling exactly where the fire is, or run to the power house and tell the man in charge exactly where the fire is.

4. The power house whistle will sound the fire alarm. Blow three blasts of the whistle to indicate a fire. Follow this by short regular blasts counting the number of the alarm box pulled.

Metallization in the Oil Refinery

By Ismar Ginsberg

We have had the occasion to discuss the question of protecting iron and and steel surfaces against oxidation and attack by corrosive chemicals, from the standpoint of the oil refinery. It is safe to say that this is a matter which is continually agitating the minds of refinery superintendents and engineers, and one that is never so far from actual solution as when it is apparently conclusively solved. The point is that there are many different agents and methods which can be used to advantage for this purpose, but it is still doubtful which will give the best results. It is therefore interesting and indeed important to every oil man, who is concerned with this matter, to consider carefully all the available rust- and oxidation-proof methods and to select that one which will give him the best results under his special operating conditions. It is quite conceivable that one method may be better for one refinery than it might be for another.

Any refinery engineer, who has had experience along these lines, will testify to the insidious character of the rusting process. It goes on slowly, without making any noise, but its results are as effective as if they had been produced with the force of explosion. Everywhere around the oil refinery, where the metallic parts, the pipes, the tubes, the wires, stills, agitators, tanks are exposed to the action of acids, corrosive chemicals and just ordinary air and moisture, the effects of rusting and oxidation can be seen. There is no question but that the loss of time and material, the cost of repairs, etc., are very high due to this simple process.

Conditions of Rusting

It should be remembered that the rusting of iron is effected by the combined action of moisture and oxygen, and in this connection the slightest trace of moisture will be sufficient to effect the rusting of the metal. Then again rusting is effected by the sulphurous acid in the flue gases from the boiler plant, by the carbon dioxide in the air and particularly by mists, as well as by the generation of electrical potential between iron and iron, or iron and steel. Futhermore iron behaves quite differently in the rusting process depending on the quality of the iron and its properties. Thus steel is generally quicker destroyed by corrosive agents than wrought iron, and the latter more quickly than cast iron. Furthermore, it must be remembered that when the metal is in contact with liquids, as in the case of tanks, stills, condensers and other oil refinery apparatus, the tendency for it to be destroyed is greater than when the metal is just exposed to the air.

It is further true that when the metal is riveted together, there appears to be greater corrosion than when the sheet is homogeneous. It has been concluded that the greater corrosibility is due to the galvanic action that is induced between the rivet and the metal of the sheet. It is of course well known that when the rivets are hammered together, a certain degree of compression is effected on the metal in the neighborhood of the rivet, and the result is that there will be two different kinds of metal in contact with each other around the rivet hole, although they are both intrinsically iron. Nevertheless, it is this that brings about the generation of galvanic currents, which has such potent action in accelerating the oxidation and destruction of the iron. Besides these influences there are many others which are found in the oil refinery and which affect the status of the iron, seeking to convert it back again into the oxide form and thus accomplish its destruction. It is for this reason that the subject of metal corrosion and rusting is such an important one to the oil refinery engineer.

Preventive Methods

He must be able to answer the question as to which of the various methods that are available to him for protection of iron surfaces against rusting and corrosion is the most suitable to use under his existing operating conditions.

This is to be sure not a simple querry and one that requires considerable thought. It is true that engineers and chemists have worked out various means for protecting the metal against rusting and corrosion by interposing between it and the destructive agencies a coating of some sort that is not in itself affected by these media. This would appear to be the most suitable of the methods at first glance, but it is common knowledge that in the first place it is not absolutely true that these coatings are not themselves attacked by the corrosive agents and in time destroyed, and furthermore that it is very difficult to obtain a coating or film that will remain impervious for any great length of time. It woud appear as if the proper thing to do is to render the metal itself non-rusting by effecting some change in its intrinsic make-up.

It is a fact that this problem has agitated the minds of men for many centuries, and it is true that samples of wrought iron have been uncovered in India which show no signs of rusting, although they have been exposed for thousands of years to the action of rust-producing agents.

Before going into details on the metallization process, it should be mentioned that rusting has been stopped in the case of boilers, pre-heaters, feed water heaters, condensers and the like by allowing a current to pass through the apparatus while it is being used. Good results have been obtained in this manner and no rust at all has been found under these conditions on the inner surfaces of the metal. Furthermore, the passage of the current also had the effect of preventing the formation of boiler scale.

Electrical Process

It is customary in this process to introduce the current through a piece of sheet metal which hangs in the boiler and serves as the anode, the boiler itself being the cathode. What happens is that the anode is rather quickly decomposed due to the rust formation, while the metal of the boiler remains entirely unchanged. The greater the proportion of carbon in the sheet iron, constituting the anode, the more rapidly is the metal destroyed. Polished iron can be protected against rusting for some time by means of the inoxide process. This process results in the formation of a coating of magnetic oxide of iron, Fe_3O_4, and is used largely in the protection of instruments and firearms.

The process of protecting iron and steel against rusting by coating it with a metal-

(Continued on page 42)

Relation of Volatility to Acceleration and Anti-Knock Qualities of Natural Gasoline

Presented before fifth annual convention of the Association of Natural Gasoline Manufacturers

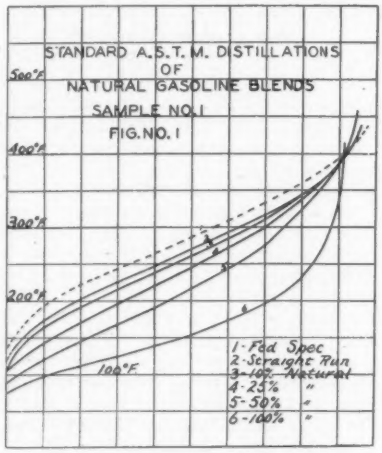
By Drs. E. H. Leslie and G. G. Brown
Professors of Chemical Engineering at the University of Michigan

THE motoring public is generally aware of the fact that ease of starting and acceleration are due largely to the more volatile components in gasoline. "Detonation" was not recognized, except as a "carbon knock" until about twelve years ago, when the refineries began to include more and more of the heavier fractions in commercial gasoline, steadily raising the end point from 300 degrees Fahrenheit to 437 degrees Fahrenheit, compelling the manufacturer of motor vehicles to build engines of lower compression pressures.

Natural gasoline, being composed only of the more volatile components of federal specification gasoline, and used generally to increase the volatility of motor fuel, is, by virtue of its volatility, essentially the cream of the gasoline fraction.

For the tests reported in this paper, straight run gasoline, obtained through a local dealer, having the A. S. T. M. distillation curve as shown by Curve 2, Figure 1, and A. P. I. gravity 57.5, was used as a standard blending stock. For acceleration and power tests this straight run stock was blended with natural gasoline hereafter designated as natural gasoline sample No. 1, having the A. S. T. M. distillation curve as shown by Curve 6, Figure 1 and A. P. I. gravity of 77.1 and 94 per cent recovery. In addition to these two fuels, blends containing 10, 25 and 50 per cent by volume of natural gasoline No. 1 were made, having the distillation curves as shown by Curves 3, 4 and 5, Figure 1, and A. P. I. gravities of 60.4, 63.0 and 66.9. Curve 1, showing the federal specification gasoline, is given for reference in Figure 1 and all other figures showing distillation curves.

The first tests conducted were for ease of starting and freedom from backfiring. These tests were made on a Franklin air-cooled, six-cylinder, valve-in-head engine, driving an air dynamometer. It would be desirable to make these tests on a cold engine to represent actual starting conditions, but this is practically impossible because the engine becomes warm while the test is being made, making consistent



results on a cold engine out of the question. For this reason these tests were made after the engine was at operating temperature. But in order to approximate starting conditions, the exhaust manifold was not connected to the hot spot on the intake manifold as is the standard method of operation. This method of testing with the intake manifold unheated is designated on the curves by "heat off."

Starting Test

The starting test was conducted by setting the throttle at one-fourth open, closing the choke, and pressing the starter button until the first explosion occurred, when the engine would operate under its own power. The ease, or rather difficulty, of starting is indicated by the number of revolutions of the engine before the first explosion. The tests were repeated six times and averaged, with the results shown in Table I and by the lower curve of Figure 2.

TABLE I

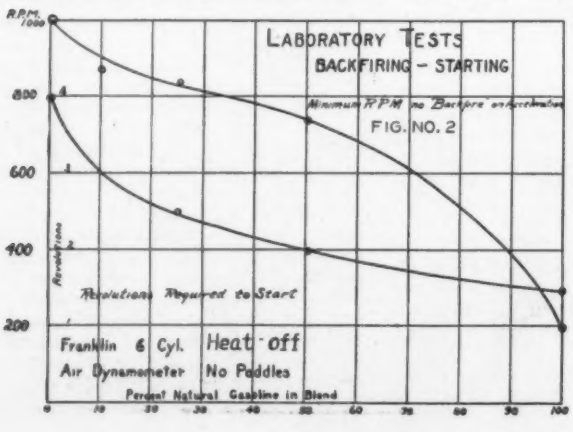
Percentage of Natural Gasoline No. 1 in Blend	Number of Revolutions Required to Start Engine, Throttle One-Fourth Open, Choke Closed.
0	4.0
10	3.0
25	2.5
50	2.0
100	1.5

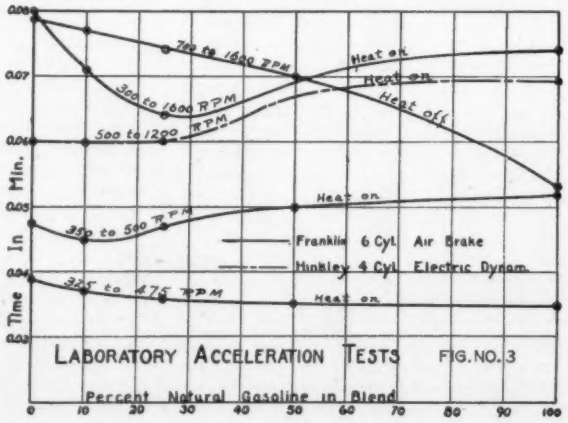
The tests to determine tendency to backfire consisted in determining the slowest speed at which the engine could be operated without a sudden opening of the throttle to the full open position causing a backfire. The data obtained in this series of tests are given in Table II and are represented by the upper curve in Figure 2. It was found that the engine could not be operated at less than 1,000 R.P.M. with the straight run gasoline without causing a backfire when the throttle was suddenly opened, but that the engine could be operated at 200 R.P.M. when using natural gasoline No. 1 without causing a backfire upon sudden opening of the throttle.

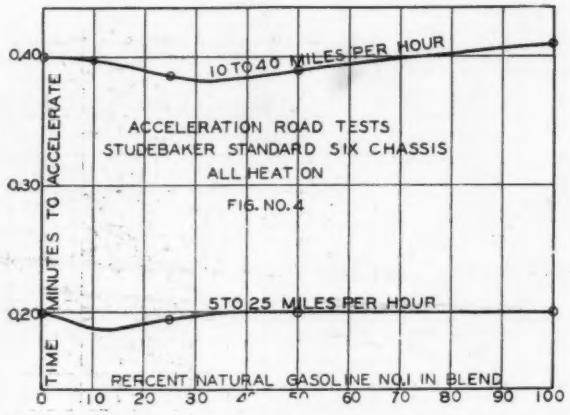
TABLE II

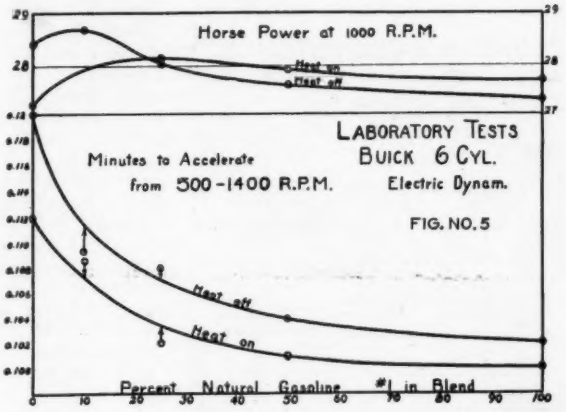
Percentage of Natural Gasoline No. 1 Blend	Minimum R.P.M. Required to Prevent Backfiring Upon Sudden Opening of Throttle to Full Position
0	1,000
10	870
25	830
50	750
100	200

Laboratory acceleration tests were made with the same fuels on the same engine,









with the manifold unheated. These tests consisted in measuring the time required to accelerate the engine and air dynamometer from 700 R.P.M. to 1600 R.P.M. The initial speed of 700 R.P.M. was chosen because it was the lowest speed at which the engine would operate smoothly on the straight run gasoline. These data, reported in Table III and Figure 3 ,represent the average of six check determinations. The time required to accelerate this engine with the unheated manifold from 700 R.P.M. to 1600 R.P.M. when using straight run gasoline was almost 0.08 minutes (4 4/5 seconds). The time required decreased steadily with increasing natural gasoline in the fuel blend to 0.053 minutes (3 1/5 seconds), when using straight natural gasoline.

Heavier Load

Further acceleration tests were conducted with the exhaust heat on the intake manifold, as is the usual method for this engine. With the intake manifold heated, the engine could be operated smoothly at 300 R.P.M. on the straight run gasoline. Accordingly these tests consisted in measuring the time required to accelerate the engine and dynamometer from 300 R.P.M. to 1600 R.P.M. The results are given in Table III and Figure 3.

Larger paddles were then bolted on the arms of the air dynamometer to increase the load on the engine. Acceleration tests were then made in the same manner as described, from 350 to 500 R.P.M. and from 325 to 475 R.P.M.

The data obtained from these tests are tabulated in Table III and plotted in Figure 3.

Comparison of these data brings out several interesting facts.

1. Time required to accelerate to relatively high speeds, 1600 R.P.M., under light or moderate load, and at very low speeds, is less for natural gasoline than for straight run gasoline.

2. With a heated manifold the best acceleration is obtained with 30 per cent natural gasoline in the blend, when the engine operating under moderate load, and with 15 per cent natural gasoline in the blend when operating at moderate load but at low speeds.

3. With a heated manifold and accelerating from very low speeds, the best results are obtained with about 50 per cent of natural gasoline in the blend.

4. A heated manifold gives better acceleration except with very volatile fuel such as straight natural gasoline or those blends containing large amounts of natural gasoline.

It must be kept in mind that the conditions throughout all tests were such as usually obtain in modern automobile engines built and adjusted for ordinary commercial gasoline, and that engine or carburetor characteristics play a very important part. For this reason further tests on engines of other types were considered necessary to show the effect of full volatility independent of any individual engine characteristics.

Road Tests

The data given in Table IV and plotted as the broken line in Figure 3 were obtained by determining the time requird to accelerate a four-cylinder, ell-head, water-cooled Hinkley truck engine from 500 to 1200 R.P.M. The engine was governed at 1200 R.P.M. so that this speed could not be exceeded. The manifold was of the ramshorn type and heated. This type of manifold has pockets in which the less volatile liquid fuel collects at low gas velocities and is swept out of the manifold into the cylinders at the higher gas velocities accompanying higher speeds. For this reason the distribution of the less volatile fuel is poor, giving results which differ somewhat from those obtained on the six-cylinder air-cooled engine. However, this test verifies the conclusion that for consideration of acceleration the volatility should not exceed that corresponding to 30 per cent natural gasoline if the intake manifold is heated by the full heat of the exhaust.

Actual road tests for acceleration were made with one of the University's test cars, a Studebaker standard six chassis, ell-head, water-cooled engine. These tests were made by observing the time required to accelerate from 10 to 40 miles per hour and from 5 to 25 miles per hour with a heated manifold. In order to eliminate any wind effect the test was conducted by driving up and down a chosen section of level highway and averaging the results. The third and fourth columns of Table IV and the curves of Figure 4 give the results of these tests.

The results of the road tests are exactly equivalent to those obtained in the laboratory, and verify the conclusion that with a manifold heated by the full heat of the exhaust, a fuel volatility corresponding to that of a 30 per cent natural gasoline blend gives the best acceleration to relatively high speeds, and that a fuel volatility correspond-

TABLE III.

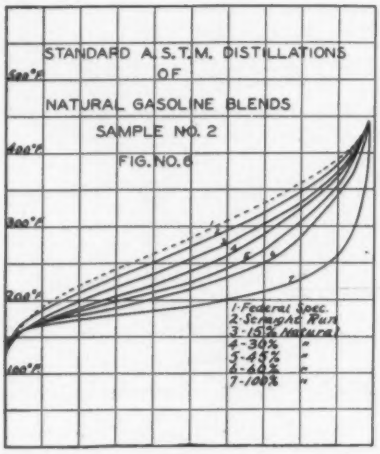
Percentage of Natural Gasoline No. 1 in Blend	Minutes Required to Accelerate — Moderate Load: Cold Manifold From 700 to 1600 R.P.M.	Moderate Load: Hot Manifold From 300 to 1600 R.P.M.	Heavy Load: Hot Manifold From 350 to 500 R.P.M.	Heavy Load: Hot Manifold From 325 to 475 R.P.M.
0	0.079	0.08	0.0475	0.039
10	0.077	0.071	0.045	0.037
25	0.074	0.064	0.047	0.036
50	0.070	0.069	0.05	0.035
100	0.053	0.074	0.052	0.035

TABLE IV.

Percentage of Natural Gasoline No. 1 in Blend	Minutes to Accelerate — 4-Cylinder Engine—Heat On: 500 to 1200 R.P.M.	6-Cylinder Engine—Heat On: 10 to 40 Miles per Hour	6-Cylinder Engine—Heat On: 5 to 25 Miles per Hour
0	.060	.400	.200
10	.060	.387	.188
25	.060	.385	.195
50	.067	.390	.200
100	.069	.410	.200

TABLE V.

Percentage of Natural Gasoline No. 1 in Blend	Minutes to Accelerate 500 R.P.M. to 1400 R.P.M.: Heat Off	Minutes to Accelerate 500 R.P.M. to 1400 R.P.M.: Heat On	Horsepower at 1000 R.P.M.: Heat Off	Horsepower at 1000 R.P.M.: Heat On
0	0.120	0.112	28.4	27.2
10	0.109	0.1085	28.7	27.9
25	0.108	0.102	28.0	28.1
50	0.104	0.101	27.6	27.9
100	0.102	0.100	27.3	27.7



ing to that of 15 per cent natural gasoline blend gives the best acceleration at low speeds.

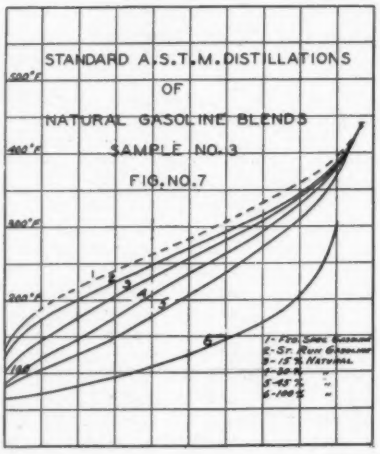
The three engines used in the above tests were equipped with manifolds heated by the full heat of the exhaust. Further tests were made on a Buick six-cylinder, valve-in-head, water-cooled engine equipped with an intake manifold heated by the full heat of the exhaust only when the throttle is nearly closed. As the throttle is opened, a butterfly valve in the exhaust pipe is opened automatically, allowing the exhaust gases to pass directly through the exhaust pipe without heating the intake manifold. Acceleration tests were made on this engine in the same manner as has been described. The results (Table V and Figure 5) are quite different from those obtained on engines in which the entire heat of the exhaust strikes the intake manifold. In the tests reported in Table V and plotted Figure 5, "Heat Off" indicates no exhaust heat on the intake manifold, and "Heat On" indicates a variable amount of heat decreasing with opening throttle in the manner described.

The power developed at 1000 R.P.M. with open throttle was determined by means of the electric dynamometer. As part of the exhaust gases by-pass the intake manifold at open throttle, "Heat On" indicates less heat than in the case of the other engines.

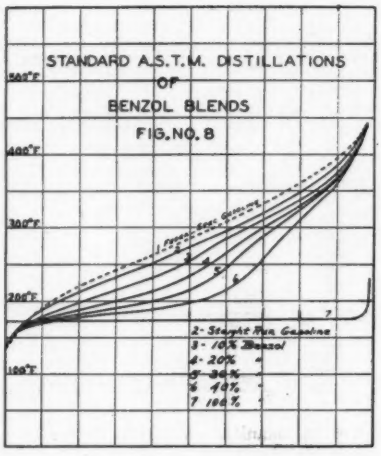
These results show a 12 per cent increase in acceleration with a heated manifold as the fuel volatility is increased from that corresponding to the straight run gasoline to that corresponding to straight natural gasoline, and a similar somewhat larger increase in acceleration with a cold manifold. Table II shows a 33 per cent increase in acceleration from 700 R.P.M. with a cold manifold on the air-cooled engine. The difference in the case of the hot manifold may be largely explained as due to the differences in manifold heating control. With cold manifolds the results are similar, differing in degree only, and may be explained as due to the different engine characteristics and to the different speeds at which the tests were run.

Generalizations

As is to be expected, the power readings indicate a greater power output with a cold manifold, at least with the



less volatile fuel. The reason for the power increase in the case of more volatile fuel, when using a heated manifold, is not clear, unless it be due to the carburetor characteristics or adjustment. The curves of Figure 5 indicate that under the conditions of the test the power output may be slightly increased by using a more volatile fuel that the straight run gasoline, but that power may be slightly decreased if the fuel is too volatile. About 30 per cent of natural gasoline in the blend gave the maximum power with a heated manifold and about 10 per cent of natural gasoline gave the maximum power with a cold manifold. It will be noticed that the decrease in power when using straight natural gasoline is negligible with a heated manifold and more noticeable with a cold manifold. These results need further verification before they may be taken as general truths.



The acceleration tests on engines of four different types are sufficiently complete to allow a few generalizations.

1. With a cold manifold, or a manifold heated to a limited degree only, the best acceleration is obtained with the most volatile fuel.

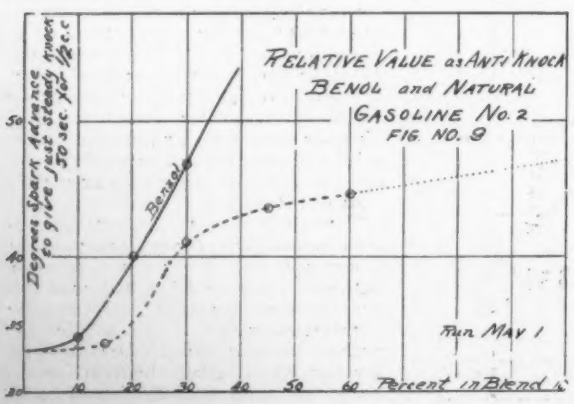
2. With a manifold exposed to the full heat of the exhaust, the best acceleration is obtained with a fuel having a volatility equivalent to that of a 15 to 30 per cent natural gasoline blend, depending upon whether acceleration to moderate or high speeds, respectively, is desired.

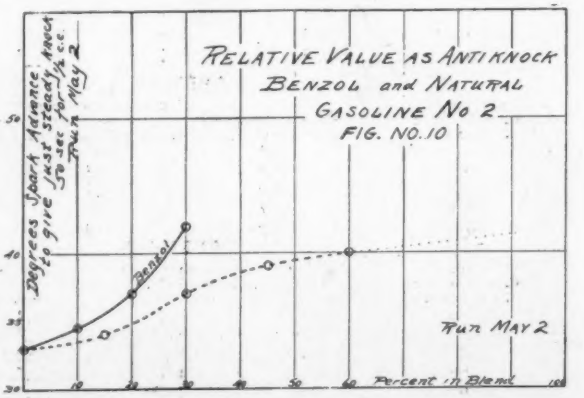
3. For acceleration at extremely low speeds a more volatile fuel is desirable.

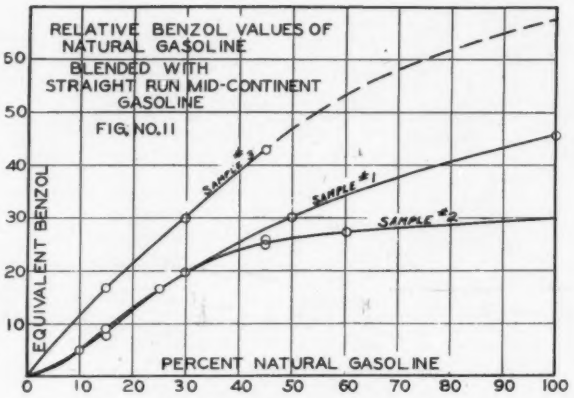
4. A manifold heated at least to a limited extent gives better acceleration with all fuels tested.

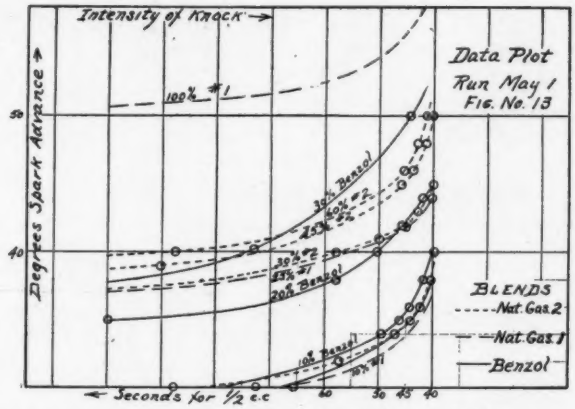
Anti-Knock Properties

Testing the knocking properties of a fuel is at best rather difficult, and, as no tentative standard method for making these tests is recognized, the results reported by various investigators, using different methods, are frequently in poor agreement, and not comparable at all. For these reasons it is necessary









to outline in some detail the method used for determining the anti-knock properties of natural gasoline.

A Delco light engine equipped with a high compression head (ratio 6.5 to 1), a standard Ford carburetor, bouncing pin and Prony brake to aid in controlling the speed was used in all the tests. The engine is air-cooled, valve-in-head, single-cylinder engine, mounted with direct driven generator on a common base. The vaporizer supplied as standard equipment with the engine, having no float chamber, needle valve or throttle, was found unsatisfactory and was replaced by the standard Ford carburetor.

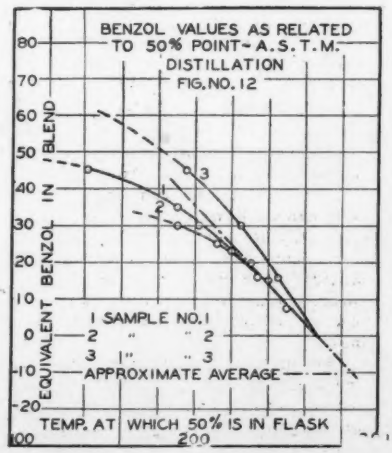
The bouncing pin, developed by the Research Laboratories of the General Motors Corporation is a satisfactory device for measuring the intensity of engine knock, and is widely used for this purpose. Essentially, the bouncing pin consists of a heavy pin resting on a small piston flush with the inner surface of the engine head. The piston is backed by a heavy spring, so that during normal combustion the pin moves up and down only a few thousandths of an inch, resting on the small piston. But when detonation occurs in the combustion chamber the bouncing pin is thrown upward clear of the piston, with an amplitude dependent upon the intensity of the knock. In order to measure the amplitude of motion of the bouncing pin, and thereby the knock intensity, electrical contacts were placed above the pin, which are pushed together when the pin is thrown free of the piston, making a longer contact as the intensity of detonation increases. These contacts are connected in series with a 110-volt D. C. power line, a 50-watt lamp and an electrolytic cell filled with 10 per cent sulphuric acid. The volume of electrolytic gas produced in the cell per unit of time is equivalent to the intensity of the engine knock, and the time required to produce a unit quantity of gas varies inversely as the intensity of the knock.

As we wished to measure the tendency of different fuels to knock, and not the relative intensity of the knock produced, the bouncing pin was used in these tests to indicate when a knock of a predetermined intensity was set up in the engine.

Series of Tests

A series of tests consisted in running the engine with a constant throttle, constant carburetor adjustment, at a constant speed of 1200 revolutions per minute, with the different fuels, and measuring the degrees spark advance before top dead center that would cause the engine to knock with the predetermined intensity as indicated by the bouncing pin. For comparison, benzol blends were run alternately with the natural gasoline blends, and the final results represent the relative effectiveness of natural gasoline to benzol in preventing engine knocking when blended with straight run Mid-Continent gasoline.

In starting a series of knocking tests, the engine was first run at full load for about 45 minutes to get it thoroughly warmed to operating temperature. Then the carburetor and spark advance were adjusted carefully until the engine was knocking mildly but consistently on straight run gasoline. The bouncing pin was carefully cleaned and adjusted to give one-half cubic centimeter of gas in 50 seconds. The carburetor bowl was then drained and the supply of natural gasoline blend connected. The spark advance was then adjusted with everything else constant, until one-half cubic centimeter of gas was collected in 50 seconds. The bowl was then drained and a check run made on straight run gasoline. If consistent results were obtained a benzol blend was then tested in the same manner. If the results were inconsistent the data were rejected and the run repeated.


BENZOL VALUES AS RELATED TO 50% POINT~A.S.T.M. DISTILLATION
FIG. NO. 12
EQUIVALENT BENZOL IN BLEND
1 SAMPLE NO. 1
2 " " 2
3 " " 3
APPROXIMATE AVERAGE
TEMP. AT WHICH 50% IS IN FLASK

For making knocking tests three different samples of natural gasoline were blended with straight run gasoline and compared with similar benzol tests. Sample No. 1, having an A. P. I. gravity of 77.1, with 94 per cent recovery, was made into 10, 25 and 50 per cent blends as shown in Figure 1.

Sample No. 2 was a special research sample and represents the residue obtained after removing the butanes and pentanes from Oklahoma natural gasoline by careful fractionation. This sample had an A. P. I. gravity of 65.2, with 100 per cent recovery and an A. S. T. M. distillation as shown by Curve 7 in Figure 6. 15, 30, 45 and 60 per cent blends were made as indicated in Figure 6.

Sample No. 3 is a composite sample of stabilized gasoline obtained from a number of plants. This sample had an A. P. I. gravity of 83.9, a recovery of 90 per cent, and an A. S. T. M. distillation as shown by curve 6, Figure 7, It is the most volatile sample tested and shows the best anti-knock properties. Blends of 15, 30 and 45 per cent were made as indicated in Figure 7.

For comparison, 10, 20, 30 and 40 per cent benzol blends were made as indicated by the A. S. T. M. distillation curves in Figure 8.

Compared With Benzol

At least two series of runs were made with each series of natural gasoline blends, under different carburetor and throttle adjustments. This was done to eliminate so far as possible any peculiar conditions of engine or atmosphere that might exist on one day or at one particular set of adjustments. It is sometimes surprising what a relatively powerful influence a slight change in conditions will have. Opening a window, changing the temperature or weather conditions, will frequently have as much effect as 10 per cent of benzol.

Having explained the method of making knocking tests, the detailed data so obtained will now be presented in tabular form. Figures 9 and 10 indicate how the data were plotted to determine the relative values of benzol and natural gasoline as anti-knock materials. These figures represent the data obtained on different days under different conditions, but with the same fuels. Al-

though different degrees of spark advance were obtained the relative values of benzol and natural gasoline as obtained in different series of runs are practically identical.

These data and other similar data obtained for the other blends plotted against equivalent benzol value in Figure 11, show the consistency of this method and the relative values of the different natural gasolines as compared to benzol when blended with straight run Mid-Continent gasoline.

Natural gasoline sample No. 3 is the most volatile, and shows the best anti-knock properties. Sample No. 1, a less volatile gasoline, has a somewhat similar curve lower on the scale. Sample No. 2, which contains only the last 30 per cent of natural gasoline, seems to possess anti-knock properties identical with sample No. 1 up to 30 per cent in the blend, but in greater amounts sample No. 2 shows less anti-knock properties than sample No. 1.

Because the natural gasolines used are very different in volatility, sample No. 2 containing no butane or pentane, and sample No. 3 containing relatively large amounts of these volatile compounds, it seemed that somewhat more consistent results might be obtained if benzol equivalents were plotted against some value representing volatility. For lack of a better value, the benzol equivalents are plotted against the temperature at which 50 per cent of the fuel is distilled in the A. S. T. M. distillation. Because all the loss on distillation may be assumed as composed of the more volatile part of the distillate, the 50 per cent point is figured backward from the upper end of the distillation curve. Figure 12 gives the results of these computations in graphical form. The 50 per cent point is not a true measure of volatility, and the compositions of the natural gasolines are very different, but Figure 12 indicates at least qualitatively the importance of volatility as a measure of anti-knock properties.

In order to indicate the different results that might be expected from different methods of making knocking tests, a complete plot of all data taken in one series is given as Figure 13. The degrees spark advance corresponds roughly to the compression ratio and represents the knocking tendency of the engine. The seconds to collect one-half cubic centimeter in the burette of the bouncing pin device varies inversely as the intensity of knock.

If the fuels were compared at 40 degrees spark advance, by measuring the intensity of knock, entirely different results would be obtained than if the fuels were compared at constant knock intensity of 45 seconds by measuring the spark advance. Tabulations on different bases are given in Table VI in order of anti-knock value.

TABLE VI.
Relative Anti-Knock Value of Blends, Based on

Knock Intensity at 40° Spark	Spark Advance for Intense Knock, 40 Sec.	Spark Advance for Steady Knock, 50 Sec.
100% Natural	100% Natural	100% Natural
60% Natural	30% Benzol	30% Benzol
30% Benzol	60% Natural	60% Natural
45% Natural	45% Natural	45% Natural
30% Natural	30% Natural	30% Natural
25% Natural	25% Natural	25% Natural
20% Benzol	20% Benzol	20% Benzol
10% Benzol	10% Benzol	10% Benzol
15% Natural	15% Natural	15% Natural
Straight Run	Straight Run	Straight Run

Another interesting point is brought out by the data plotted in Figure 13. Note that a 30 per cent natural gasoline blend detonates at a 45-second intensity when the spark is set at 42 degrees advance, and that a 20 per cent benzol blend knocks with the same intensity under the same conditions. But at a knock intensity corresponding to 60 seconds the 30 per cent natural gasoline blend will stand 39.7 degrees spark advance and the benzol only 37.5 degrees. At 37 degrees spark advance a 30 per cent natural gasoline blend will cause the bouncing pin to register one-half cubic centimeter in 100 seconds, and a 20 per cent benzol blend will register the same amount of knocking in 65 seconds, although the two blends show the same properties at 42 degrees spark advance. Similar tendencies are evident with all natural gasoline and benzol blends tested.

In general, we may say that the intensity of knock, as engine conditions are made worse, increases more rapidly with natural gasoline than with benzol, and also the intensity of knock decreases more rapidly with natural gasoline as engine conditions are improved. As on our adjustment, 50 seconds registered for one-half cubic centimeter corresponds to a steady but not violent knock, longer periods than 50 seconds really represent so-called "rough running" rather than "detonation." These data lead to the conclusion that natural gasoline blends should give a smoother-running engine than benzol blends of equal anti-knock properties.

In general, we are justified in concluding that natural gasoline blended with straight run Mid-Continent gasoline is equivalent to two-thirds as much benzol containing not more than 50 per cent of natural gasoline.

New Pacific Coast Refinery Offers Engineering Advances

(Continued from page 22)

exchangers). This fractionating equipment is all of the latest type of Southwestern bubble towers, control sections and condensers. The crude is raised in temperature to about 200 degrees F. in its travel through the control sections. It is then conducted to three Southwestern heat exchangers presenting 100 square feet of exchanger surface each, where it flows countercurrent to the hot residuum from the last still in the continuous system, and here it is heated to 350 to 375 degrees F.

From the exchangers the crude is conducted to the evaporator or separator, which is actually a bubble tower. The crude enters the tower at about two-thirds of its height where the vapors are liberated, conducted through a 10-inch vapor line to a separate tower-fractionated, then condensed and removed to run down. About 50 per cent of the entire gasoline yield is removed from the crude in this manner. The crude, accumulating at the bottom of the separator is conducted to the still and subjected to the usual distillation procedure.

Temperature Control Automatic

The towers, or dephlegmators, are all subject to temperature control by the installation of individual Foxboro automatic recorder controllers. In this connection it is interesting to note the employment of the locomotive or air brake type of air compressor, which the company has installed to furnish a constant supply of compressed air for the operation of the control instruments. These machines are automatic in their operation, comparatively inexpensive in cost, and besides requiring very little space for installing, requiring little or no attention. It is explained that they can be set to the required pressure, supplied with steam, and except for occasional inspection, can be almost forgotten.

Another item of interest in control work is the employment of a Willson-Maeullen Pyrometer. This instrument has 43 contact points, showing the temperature of practically all points of interest about the plant equipment. The operator is thus provided with information as to the accurate operation and functioning of each piece of equipment with which he is working.

The plant is equipped with both steam and electrically driven pumps for transferring, loading and charging oil. In line with the usual trend of refining organizations on the West Coast the company has standardized on one type of steam pump, in this instance—National Transit—in sizes, 12x9x18-inch, 10x7x12-inch and 12 x12x12-inch; with two large pumps of 18 x14x24-inch in size. These pumps handle crude oil, hot and cold residuum, and water.

With the exception of the two large steam pumps mentioned above, in position at the rear of the building, all other pumps are electrically driven Dayton Dowd centrifugal pumps, ranging in size from 1½, 2, 3, 6 and 10-inch, which are driven by Western Electric motors ranging from 1 horse power to 50-75 and 150 horse power motors. These later driving the large 10-inch pumps. There are 20 pumps of this type in the main pump house with five or six more located at points of advantage about the plant.

Electricity is brought into the plant for power purposes through a high tension line at 33,000 volts. At the plant it is stepped down to 440 volts for power use. The electricity for lighting is brought in at 4400 volts and stepped down to 220 volts on the plant yard. Further, to reduce the fire hazard, each motor is provided with automatic electric switches, actuated by oil sealed, flash proof contact

The refiner who installs a cracking proccss limited to light charging stocks is always in the frying pan or in the fire

To buy his charging stock is proving to be a costly procedure due to the increasing demand for these fractions, and to install additional equipment in order to manufacture it increases his investment and his overhead and decreases his profit

The refiner who installs the Dubbs Process charges the cheapest oil available to his cracking plant and obtains the highest yield and the greatest profit

Universal Oil Products Company
Owners of the Dubbs Process
310 South Michigan Ave
Chicago, Illinois

I. C. C. Rate Change Puts Higher Charges on Group 3 Refineries

Tulsa, Okla.—In perhaps the most drastic decision in the history of petroleum rail rates, the Interstate Commerce Commission early this month fixed a differential schedule, whose adoption by the carriers may result in $10,000,000 annually being added to the gasoline bill from group 3 territory.

The new rates came in the case of what has come to be known as the effort to Kansas refiners to get an increased differential. The new schedules allow Kansas refining points lower rates ranging of from 2 to 7 cents a hundred on gasoline and other petroleum shipments into what is known as Standard of Indiana territory.

Effect of the decision can not be known until carriers have acted in the matter. Many rate experts are doubtful about the carriers taking full advantage of the decision, on account of the possibility of reducing the volume of petroleum traffic, thus driving its transportation to pipe lines, as crude oil, for refining in the several centers of the northern territory.

From the view of refiners of Oklahoma and North Texas, the new rates mean a staggering advantage to refiners with plants in Kansas. With rates from 2 to 7 cents lower, Oklahoma refiners see the Kansas plants favored over such an extensive territory that the latter will have a distinct trade advantage.

Aside from its effect in the matter of rail charges, the decision has further importance in that the new schedule will become the basis for further changes and adjustments in petroleum rates for this territory.

Rates fixed in 1914 had prevailed as basic until the present decision was given. Previous to 1914, petroleum did not enjoy a commodity rate in the Mid-Continent. But so many rates had been established, due to growing traffic in petroleum, that a decision in that year brought petroleum into the commodity class for rates in the territory.

It was almost two years ago that Kansas refiners, known as group 2, began their effort for a change in differential over group 3 and North Texas. The case was instituted by J. F. Lawrence, now living in Tulsa. Its result was beyond his anticipation.

Following the decison he gave the following interview:

"This decision is, I think, the most important thing that has happened to the independent oil industry in the Mid-Continent field since 1914, covering as it does the only territory to which any great volume of petroleum products can be shipped in fair competition with the pipe line refineries, because of the very material increase in freight rates, since 1918, and without having been able to thoroughly analyze the resulting situation, I think it conservative to say that if the increases authorized by this decision shall go into effect, it will mean an additional burden of more than $10,000,000 a year on the independent refining industry in the Mid-Continent field. I doubt whether they can profitably operate under this additional handicap—if not, of course, the railroads would be equally, if not, greater losers.

"This decision authorizes an increase of 3 cents per hundred, equivalent to almost a quarter of a cent per gallon on shipments to Kansas City, Chicago, Peoria and other towns; increase of 2½ cents per hundred to St. Louis, Milwaukee, Keokuk and other towns. This is equivalent to a fair net profit and on the close margin at which petroleum products are sold, means all, if not more, than the net profit to the refiner.

"Taking St. Louis, Kansas City and Chicago, as an example, the refining output at each place is greater than the local consumption and the petroleum products consumed in each city originates in the Mid-Continent field, and always has been and in the future will be transported to these cities either by railroad or by pipe line. Under the present level of rates, more than one-half of the oil consumed in Chicago, St. Louis and Kansas City is transported from the Mid-Continent field through pipe lines and this percentage has been gradually and materially increasing under the present level of rates and with an additional one-quarter of a cent in transportation cost, it would not be surprising that all oils consumed in these cities would be transported through pipe lines and, therefore, lost by the railroads. This is a matter that should appeal to the sound judgment and discretion of the railroads and I think they will hesitate long before they put into effect a rate, though authorized by the commission, which would take away from them this immense revenue.

"Some of the same railroads seeking an increase in the rate of 36 cents per hundred from Tulsa to Chicago, are today urging the commission to permit them to transport the same commodity from Tulsa to New Orleans at 22 cents per hundred. In the latter case, they say that a higher rate would cause them to lose the movement and they submit that they can transport gasoline from Tulsa to New Orleans for 22 cents per hundred weight at a profit, yet, in the face of the stern realities, they are seeking an increase in the 36-cent rate for a much shorter distance to Chicago. An analysis of the reports of the railroads of the United States shows that today they are losing almost $400,000 per day on oil alone, because the freight rates are too high.

"It is my understanding that the most prosperous railroad in the state of Oklahoma according to the annual reports, is the Midland Valley and that the Midland Valley shows a higher percentage of their tonnage to be oil than any other railroad. It is also a fact that the revenue received by the Midland Valley for transporting oil is lower per mile than practically any other railroad in Oklahoma. The answer is: The profit comes from volume, and not from high prohibitive rates. It is one thing to publish a rate, and it is another thing to get that commodity to transport. I believe the railroads will admit that if all of the oil that moves out of Oklahoma, North Texas, and Kansas should be transported by rail instead of pipe line to the points where that oil is consumed, the revenues of the carriers would be materially increased even at one-half of the present rate. Henry Ford bought a railroad, which was hopelessly insolvent, and the first act was to reduce rates to a point where traffic would move. Careful study of the method employed by a successful railroad operator might be more beneficial to some of the railroads, than a rate analysis trying to figure out how an increased rate can be published.

"The railroads recognize a river as a competitor even though no steamboats ply its channel. They refuse to recognize a pipe line actually in existence, pumping oil each day, and I have been told that the railroad takes the position that a railroad cannot compete with a pipe line—if they will only investigate they will find that the actual transportation of oil by rail costs less than does the actual transportation of the same commodity, the same distance by pipe line. In other

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bottoms, which are located in a separate switch building. Pressing a button at the motor on the pump desired is all that is required for starting and operating a pump.

Treating

The company treats all its gasoline and kerosene in two 1000 barrel agitators, using both acid and caustic. After chemical treatment the oils are subjected to contact clay treatment. Figure 6 shows the lower or ground floor arrangement of the contact clay system or filter house. The gasoline and kerosene are handled by separate mixing units and filtered through separate No. 7 Sweetland filter presses. The gasoline, or kerosene, is pumped into the bottom of the perpendicular mixing chamber, while the clay is dropped in predetermined quantities into the top of the mixing chamber. From here it is forced through three inch lines into the Sweetland Press. Oils are handled at the rate of approximately 250 barrels per hour, through the filter presses, which equipment is located on the second floor of the building. The gasoline, after passing through the press is conducted to storage, finished, ready for shipment.

The officers of the Western Oil & Refining Company are: Richard Florian, president; R. R. Rakestraw, vice-president and chief engineer; A. W. Taylor, vice-president; A. A. G. Scherbel, secretary and treasurer.

"Piercteel" Seamless Tubes

The trade mark "Piercteel" identifies seamless steel tubes manufactured by Pittsburgh Steel Products Company, and is your assurance of the uniform high quality that has always been a feature of our products.

"Piercteel" Still Tubing and Boiler Tubes

are made by piercing solid billets of selected basic open hearth steel. They prove their superiority by their strength and durability under the severe and exacting conditions of oil refining. We also manufacture "Piercteel" casing, tubing and drill pipe for oil production purposes.

Our new booklet "Seamless Steel Tubes" will be sent free upon request.

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words, with a pipe line already constructed and a railroad already constructed from Tulsa to Chicago, the actual cost of transporting 20,000 barrels of oil per day will cost more in actual money through the pipe line than by rail. This being true there is no reason for a pipe line. All the railroads in Oklahoma have vacant space on their rails exceeding 50 per cent of their capacity and this vacant space could transport every gallon of oil that is transported out of Oklahoma and the only additional cost would be the labor, fuel and machinery used in the actual transportation.

"The position taken by the Kansas refiners in the beginning and closely followed to the very end of the case was that the differential should be created by reducing rates and that no rate from Oklahoma should be increased. I am sure that the conditions not only justify, but demand that the railroads in this particular instance create the differential prescribed by reducing rates and under no condition or circumstance should a single rate be increased, unless at some particular point where some perculiar situation might justify a slight adjustment but in the main if the carriers should comply with the decision by reducing and not increasing rates, they would profit, otherwise, they are bound to lose."

Metallization in the Oil Refinery

(*Continued from page 33*)

lic film is known to all as the Schoop process. It need not be described in detail here, for the manner in which it works is very generally known. But its application to the protection of metallic surfaces in the oil refinery is an application which is not so widely used at present.

The instrument or pistol that is employed in spraying the metal need not be described here in detail. Suffice it to say that the pistol consists essentially of three parts. The first is the frame work of the pistol with its cover, distributing bath and various tubes. The second part is the driving mechanism for feeding the metal. The third part is the system of nozzles. In some types of piston the driving mechanism consists of a small turbine which is built into the structure of the pistol itself. Compressed air is then fed to this turbine. The metal is fed into the apparatus by means of proper geared device. The speed of the metal feed must be maintained regular and can be controlled at will. The metal comes in contact with a gas flame under pressure, generally oxyhydrogen, and is melted. The compressed air atomizes it at the same time and it is blown against the surface of the object that is being metallized in this condition. Due to the cooling action of the compressed air stream, the temperature of the atomized metal is so low that it will not burn the hand.

Atomizing

In the place of oxyhydrogen mixture, it is also possible to employ acetylene-oxygen and illuminating gas-oxygen mixtures. There have been various improvements made in the construction of the atomizing device or pistol, so that the minimum of skill is required to manipulate the apparatus and obtained good results with it. The amount of metal that can be handled by the pistol varies very considerably, as it depends on the melting point of the metal. It can be anywhere from six kilograms to eight tenths of a kilogram per hour.

The interesting feature of the process is the thickness of the film of metal over the surface of the metallized object. It is understandable that the thickness of this coating will determine to some degree the potency of the protection offered. This thickness is dependent on the duration of the spraying and can readily be regulated from a mere film to a coating of several millimeters thick. When a coating is being applied to an object for the purpose of protecting it against rusting, the thickness of the film need be only one thirtieth of a millimetter, but when the coating is applied for the purpose of protection against the action of chemicals, such as, sulphuric acid, chlorine gas and the like, its thickness should vary between three tenths to four tenths of a millimeter.

One feature of the coating is important. That is that when the surface is rough, to which it is applied, the particles of sprayed metal will adhere more firmly than on a smooth surface. For this reason it is well to rough up the surfaces, which are to be metallized, before the metal is sprayed onto them. This is done with the aid of a sand blast. Then it will be found that the metal will adhere so firmly to the roughened surface that it cannot be removed from it except by filing or chiseling. The sprayed metal can be readily brushed, polished, and it can be colored and treated in other desirable ways. These operations can be performed without any danger of injuring the rust-protective properties of the coating.

Metals for Spraying

There are various metals which can be sprayed on to the surface that it is desired to protect and the kind of metal employed will be determined by the effect that it is desired to produce. Thus, for example, zinc metal can be sprayed, and the coating that is obtained in this manner will protect the iron and steel most effectively against rust-producing agents. Aluminum coatings are also used. These protect the metal against combustion processes, the action of high temperatures, flue gases and the like. It has been found that outside of all the other advantages that are gained with the use of aluminum sprayed metal, the life of the article or part, thus treated, is materially increased.

Lead coatings are very advantageous in protecting the iron and steel metal against the action of chemicals, such as acids, lyes and the like. The lead coating is easily produced on cast iron and wrought iron and in fact any other metal that is employed in making parts of apparatus in the oil refinery. Coatings of tin, aluminum, copper and bronze have been found to be very useful and advantageous for apparatus that are employed in the paraffine and candle plant.

The results that have been obtained with the use of the sprayed metallic coating have indicated that it probably is the most effective way in which to protect metal against the action of rust-producing agents and chemicals which attack and destroy iron and steel. It is a real material aid to the oil refinery engineer and is of prime importance to him as a form of solution of the rust and chemical protection problem. The reader is referred for further information to an article which was published in Petroleum Zeitschrift, volume 21, pages 1388 ff., from which some of the information contained in this article has been taken.

Mechanical Packing Company Add Branch in Houston

Houston, Texas.—The Garlock Packing Company, manufacturers of mechanical packings, whose general offices and factories are located at Palmyra, N. Y., announce the opening of a new branch sales office and warehouse at 805 Washington Avenue, Houston, Texas.

In their Houston warehouse they are carrying a large stock of standard sizes of mechanical packings, in order to enhance the value of their mechanical packing service to the oil fields in Texas and adjacent territories. It will also expedite deliveries on packings of special sizes from their branch factory at Birmingham, Ala., and general factory at Palmyra, N. Y.

The Garlock Packing Company's district sales offices and warehouse which are maintained in all principal industrial centers can render a 48-hour or less delivery service on all standard mechanical packings, such as valve stem packing, rod packing, sheet packing, gaskets, etc.

Tagliabue Issues Special Instrument Catalog

The C. J. Tagliabue Manufacturing Company, 18 to 88 Thirty-second Street, Brooklyn, N. Y., has recently issued what it calls its "most attractive and useful" catalog covering Tag Thermometers and Hydrometers. Special effort was made to secure a printing and engraving job that would show the instruments in as near actual likeness as possible. The result is a catalog far above the average in appearance. Copies will be mailed by the company upon application.

Winkler and Koch Bubble Towers Pay For Themselves in a Few Weeks

Method of Assembling
Winkler and Koch Bubble Decks
(Patent Applied For)

Absolute Separation
Increased Yields
No Rerunning
Lowered Fuel Consumption

Streams of the Following Character Can Be Obtained From a Shell Still Crude Battery:

	375 E. P. Export		Navy or Naphtha	Kerosene or 38-40 Distillate
Stream No.	1	2	3	4
I. B. P.	100°F.	326°F.	388°F.	440°F.
10%	164	350	404	462
20	200	352	406	468
30	240	356	408	472
40	261	360	410	476
50	276	362	412	480
60	290	364	414	484
70	301	367	416	488
80	312	372	418	495
90	320	376	424	501
E. P.	324	385	434	518

These Decks—

(1) can be placed in existing tower shells—

(2) are easily installed or removed—

(3) make a natural gasoline absorber of the highest efficiency—

(4) are made of cast iron throughout to resist corrosion.

WINKLER & KOCH

CONSULTING AND CONSTRUCTION ENGINEERS

429 First National Bank Building **Wichita, Kansas**

Mention Where You Saw the Advertisement

Getting High Yield From a Skimming Plant

Efficient fractionation and temperature control cut fuel and labor costs at West Kansas plant

By Roye Munsell
Staff Representative

AN example of what may be done in the way of securing greater economy and increased efficiency in refinery operation by the installation of modern fractionating equipment is the new plant of the West Kansas Refining at Russell, Kansas.

The plant, a 2500-barrel skimming plant, operates on crude from the nearby Russell field of central west Kansas. Although the crude being run shows by standard Hempel distillation a gasoline content of 41 to 41½ per cent, the Russell refinery obtains from 43 to 43½ per cent gasoline. These results, it ought to be said, are everyday results obtained under ordinary operating conditions.

The entire plant is a model for perfect refinery control. All valves, recording instruments, etc., have been placed with this objective in view. The temperature of the vapors leaving the towers seldom vary more than 5 degrees over a period of tweny-four hours, and the temperature of the oil leaving the still is maintained constant without difficulty.

Labor Cost Low

The control obtained not only makes possible the efficient operation, but a minimum amount of labor to keep things going. Nine men are the maximum number required.

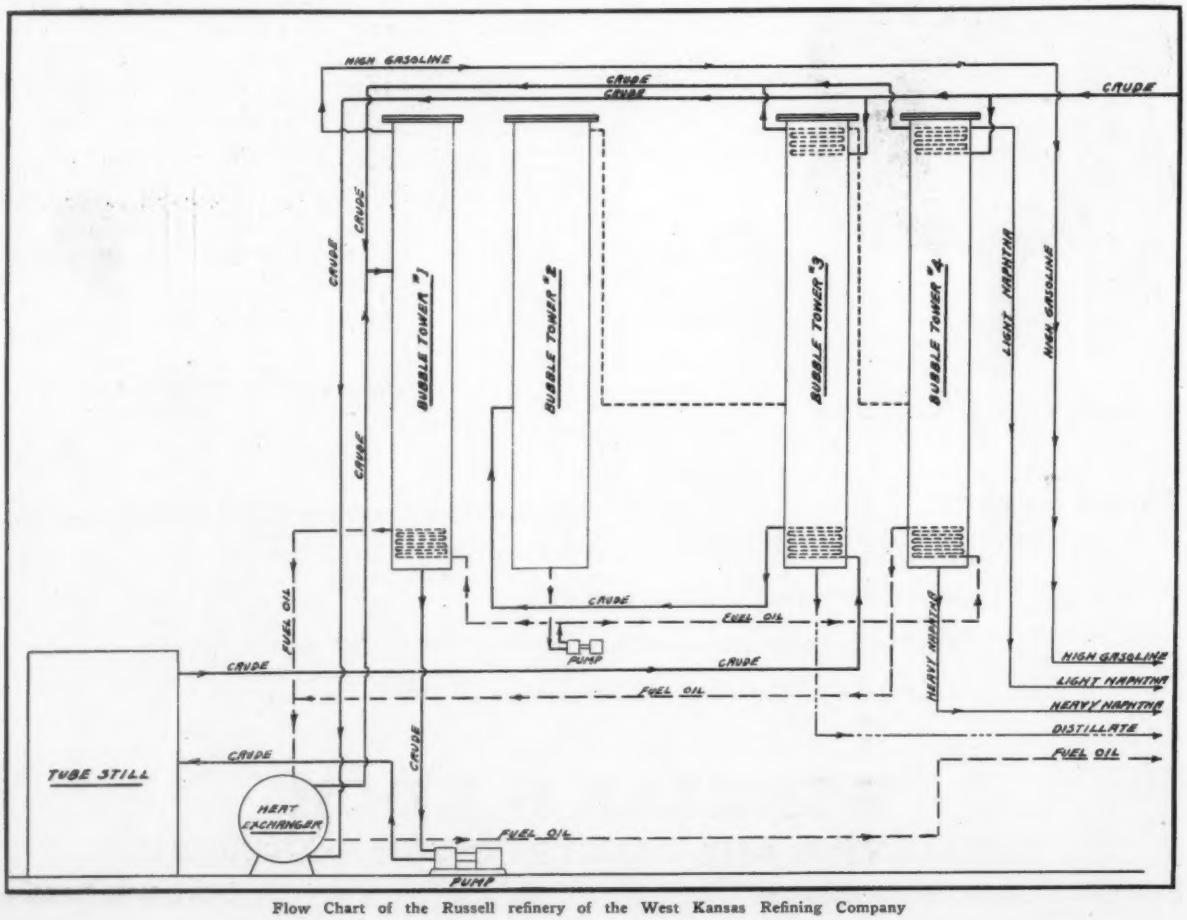
The fractionating equipment consists of one tube still and four bubble towers. Figure 1 shows by a cross section view something of the design and construction of the towers.

The hook-up of the plant is rather unusual as is shown by the accompanying flow chart. Referring to the flow chart:

The crude oil is charged into the system as follows: part goes through a closed coil in the top of No. 4 tower, part through a closed coil in the top of No. 3 tower, and the balance through the heat exchanger, exchanging heat with the outgoing fuel oil. The crude is cut through the coils in No. 3 and No. 4 towers to maintain the temperature desired at the top of these towers.

Streams Combined

The two streams of crude from the tops of No. 3 and No. 4 towers, and the stream from the heat exchanger, are combined and put into No. 1 tower at about the center. It will be noted that the hot fuel oil is passed through the reboiler section in the bottom of this tower before it



Flow Chart of the Russell refinery of the West Kansas Refining Company

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In an effort to prolong the service of his still linings and boiler settings, the Refinery Superintendent decided to use ADAMANT, the *original* high temperature fire brick cement.

In the furnaces of ten of the refinery's stills and four of the boilers, brickwork was laid up with ADAMANT. Thin "dipped" joints were used. The fire-exposed surfaces of the finished brickwork were painted with one or two "facings" of ADAMANT.

The Refinery Superintendent found that the brickwork laid up and "faced" with ADAMANT had an average life of 48 months—more than three times the former life!

The Refinery Superintendent estimates that ADAMANT is saving his company over $7,000.00 yearly. Needless to say the Refinery Superintendent is extending ADAMANT'S longer life and economy to all of his plant's fire brick construction.

ADAMANT is shipped in air-tight, metal containers. 400 lbs. of ADAMANT will lay up a thousand fire brick.

Why not lengthen the life of your furnace linings, and save many of the dollars you are spending for repairs and re-linings? Use ADAMANT when you next repair. Filling in and mailing the coupon below does not obligate you.

**We are privileged to give this refinery's name on request.*

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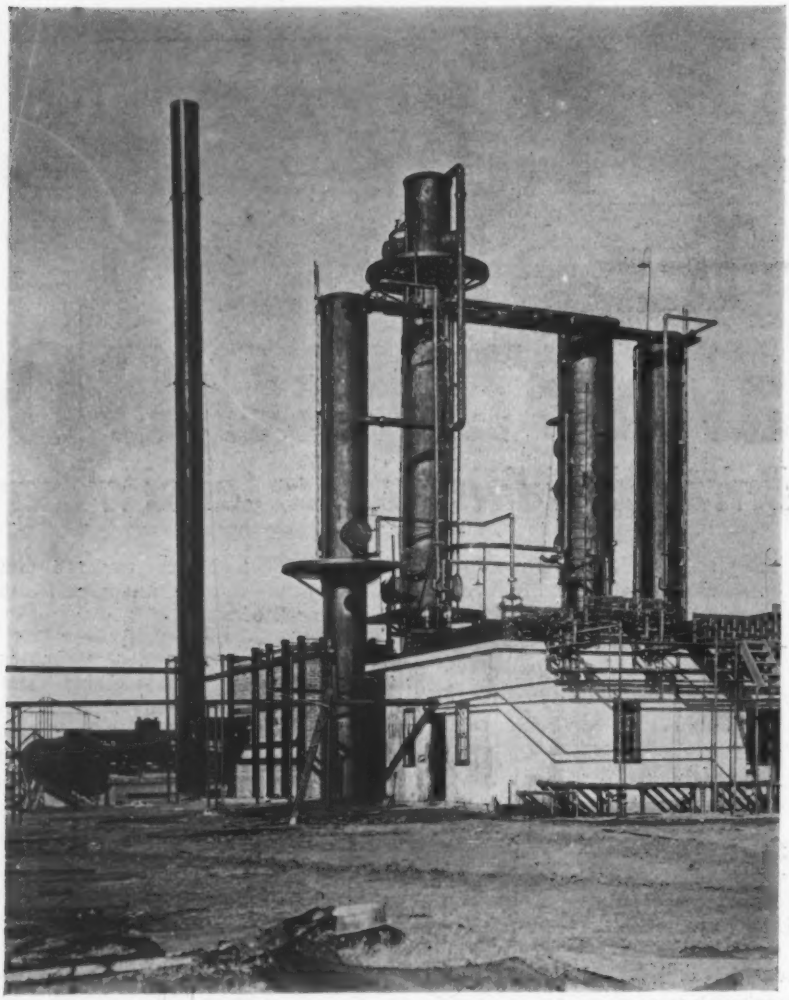


Tube still and bubble tower installed at the Russell plant of the West Kansas Refining Company

reaches the heat exchanger. The first cut, a high gravity gasoline running about 79, is taken off the top of No. 1 tower.

The slightly heated crude oil is then taken from the bottom of No. 1 tower and put through the tube still. From the tube still, it goes into the reboiler section in the bottom of No. 3, and thence into No. 2 tower at the center.

Fuel oil of 24.5 gravity is taken off the bottom of No. 2 tower, part of it going into the reboiler section in the bottom of No. 4 tower and part through the reboiler section in the bottom of No. 1 tower, as has already been mentioned. Finally, after passing through the heat exchanger, where heat is exchanged with the incoming crude, the fuel oil is run to storage.

The vapors taken off the top of No. 2 tower are put into the middle section of No. 3 tower. Distillate of 38.5 gravity is taken off the bottom of No. 3 tower.

The vapors from the top of No. 3 tower are discharged into the middle section of No. 4 tower. A light naphtha of some 57.6 gravity is taken off the top of No. 4 tower and a heavy naphtha of 45.4 gravity off the bottom of the same tower.

By means of the reboiler section in the bottom of No. 4 tower, it is being found possible to take a light naphtha off the top having an end point lower than the initial boiling point of the heavy naphtha taken off the bottom of the same tower.

Fuel Item Low

No kerosene is being made at the Russell refinery it will be noted.

All heat necessary for reboiling in the bottoms of the towers, which is essential to high yields, is furnished directly or indirectly by the pipe still.

The total fuel consumption of the entire plant is less than 4 per cent. Since most of the pumps are electric motor driven, little steam is required for operation. The total power requirements are approximately 45 H. P.

Because the pumps are motor driven, the smoothest plant operation is easily obtained. Steam pumps have been installed, however, as standbys.

The plant was built under the supervision of Keith, Winkler & Koch, now Winkler and Koch, construction engineers, of Wichita, Kansas. The bubble towers used at this plant are of their design.

Hills - McCanna Adds to Its Selling Staff

Chicago.—Hills-McCanna Company of this city, manufacturers of steam specialties which have found wide market in the refining industry, announce the opening of an Eastern sales office at Room 704, 53 Park Place, New York City. F. R. Glenner will have charge of the office.

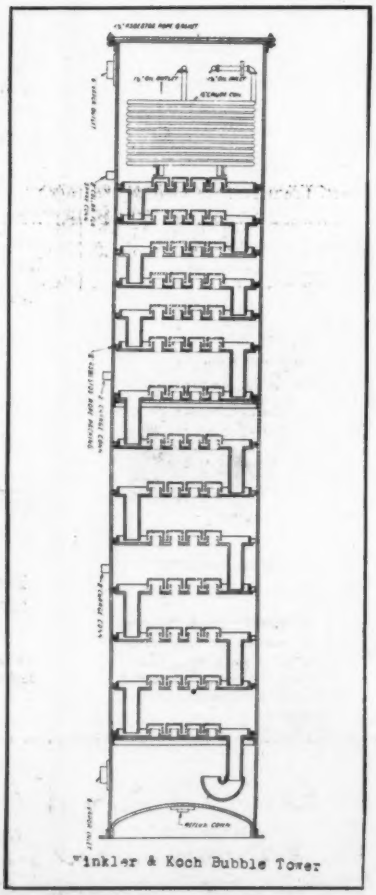
A. B. Harrison, formerly in charge of the Tulsa office of Hills-McCanna, has been transferred to Chicago, in charge of refinery sales. The Tulsa office has been placed in charge of Edward Soph, 124 W. Third Street.

Wilson-Snyder Company Now Has Office In Dallas

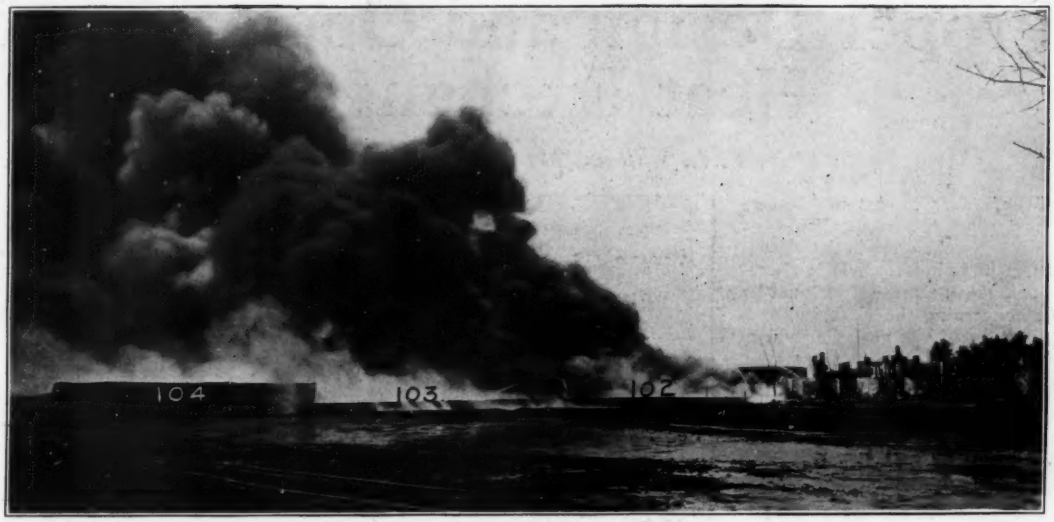
Pittsburgh, Pa.—Increasing use of Wilson-Snyder pumps in the oil industry has made it necessary for a Southwestern office to be established, and this office has been located at 1605 Kirby Building, Dallas, Texas, with G. W. Walton in charge.

Mr. Walton was formerly employed by The National Supply Company and is well acquainted with the territory which he is to serve.

Wilson-Snyder pumps are used extensively for pipe-line, refinery, and oil transfer service.



Winkler & Koch Bubble Tower



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Proper Design and Operation of Heat Exchangers

By F. L. Kallam, M. E. and A. F. Semino

As an appendix to their discussion on heat exchangers concluded in the last issue of The Refiner and Natural Gasoline Manufacturer, the authors are presenting the result of their study into the viscosity of oils.

One of the important factors governing the transmission of heat in exchangers is the viscosity of the liquids involved. It is therefore evident that accurate data must be available concerning the viscosity.

The series of articles on heat exchangers started in the March issue of The Refiner and with the publication of the accompanying discussion gives the industry the most complete and comprehensive study that has yet been made of this subject.—The Editor.

ONE of the important factors governing the transmission of heat in exchangers is the viscosity of the liquids involved. It is therefore evident that accurate data must be available concerning the viscosity.

The viscosity of oils varies considerably over a range of temperatures. Since the viscosity is required for the mean operating temperature, it becomes necessary to know the viscosity-temperature relation for the range of temperatures occurring in practice.

The viscosity of liquids is determined by an instrument known as a viscosimeter. The Saybolt Universal Viscosimeter is the one most generally used in the United States, although other types are also in use. Determination of the time in seconds required for 60 c.c. of the fluid to escape from the viscosimeter through a fine capillary tube, under gravity head, constitutes the Saybolt Viscosity. The Saybolt Viscosity must first be converted into absolute units of viscosity before it can be used in heat transfer calculations.

The absolute viscosity in the centimeter-gram-second system of units is the force in dynes necessary to move a surface one square centimeter in area past another similar parallel surface with a velocity of one centimeter per second, the two surfaces being one centimeter apart and the intervening space being filled with viscous fluid.

The unit of absolute viscosity is called the poise and is equal to one dyne per square centimeter. A smaller unit, called the centipoise, which is equal to one one-hundredth of a poise, is quite often used.

Another viscosity term in general use is the kinematic viscosity, which is the absolute viscosity divided by the specific gravity.

The Saybolt Viscosity of a liquid may be converted into its corresponding, kinematic viscosity by the following fomula:

$$\text{Kinematic Viscosity} = 0.00220\ s - \frac{1.80}{s}$$

where s = Saybolt Seconds.

The conversion of Saybolt Seconds to kinematic viscosity has been simplified by the chart in Figure No. 9.

The absolute viscosity is readily determined from its relation to the kinematic viscosity.

The viscosity of an oil is greatly decreased by increasing its temperature, the greatest change occurring up to about 150 degrees F. Above this temperature, the rate of change in viscosity decreases. In recent years investigators have found that the viscosity-temperature relation of an oil plots as a straight line on logarithmic cross-section paper. This greatly simplifies the determination of the viscosity for different temperatures, since it is merely necessary to measure the viscosity for two temperatures and plot the results by means of a straight line drawn through the two points on logarithmic cross-section paper.

The viscosity-temperature curves of a large number of California oils used in commercial work are shown in Figure Nos. 10 and 11.

The curves as plotted show the viscosity-temperature relation for oils of approximately the same gravities; in other words, they are composites of a large number of oils. A great variation will be found in the viscosity of oils of the same gravity, even when produced from the same field or basin. A variation of as high as twenty per cent has been observed in some cases, but in spite of this fact, such curves are not without value in solving heat transfer problems. The basis for the curves shown is the results of viscosities run on 600 samples of oils, part of the work being done by the authors and part by other investigators (W. E. Helmick, Shell Company of California).

Perhaps a word here in connection with the determination of viscosities will not be amiss in explaining some of these variations. Generally, no cut for water and B. S. is run on the oil being sampled. The authors have found that if the viscosity is run with a sample of clean oil, a closer viscosity-temperature relation exists. Hence it is desirable to make a distillation of the sample before determining the viscosity, by using a still with no dephlegmating column. In this manner emulsion is eliminated.

It has been observed that a lag in the viscosity exists when the oil is quickly brought up to the desired temperature. That is, the viscosity will be less than if the temperature is gradually raised to the desired point and kept constant for a short period before making the run.

In view of these facts, when considering design it is safer to make viscosity determinations on the oil to be used in the exchanger. This, however, is not always practicable, so it will be found necessary to resort to the curves.

An outstanding feature of these curves is the tendency of all curves of one family of oils to meet at a common point. This fact further simplifies the determination of the viscosity of an oil at any temperature when the viscosity at some other temperature is known. A straight line drawn through the known point and the above mentioned intersection point will give the viscosity-temperature relation for the oil. However, this method is not recommended save in those cases where inadequate information is available.

W. H. Herschel, (Physist, Bureau of Standards), gives the following points

NOMENCLATURE

A' = Mean effective transfer area—Square feet.
c = Specific heat of fluid—B.t.u. per pound per °F.
c_T = Specific heat of hot fluid—B.t.u. per pound per °F.
c_t = Specific heat of cold fluid—B.t.u. per pound per °F.
C = Coefficient of fluid friction loss depending upon W, D_1 and U.
D_1 = Internal diameter of tube—Inches.
D_2 = Shape factor—Inches.
d = Density of fluid—Pounds per cubic foot.
E = Efficiency of heat transfer—Per cent.
F = Crtical velocity factor depending upon V_s, D_2, S and U.
$J = \frac{W_T c_T}{W_t c_t}$ or $\frac{W_t c_t}{W_T c_T}$ (whichever is less than 1.)
k = Overall coefficient of conductivity.
k_e = Coefficient of conductivity of internal liquid film.
k_H = Coefficient of conductivity of external liquid film.
k_T = Coefficient of conductivity of metallic tube wall.
K = Overall heat transfer coefficient—B.t.u./Hr./Sq. ft./°F.

(Continued on next page.)

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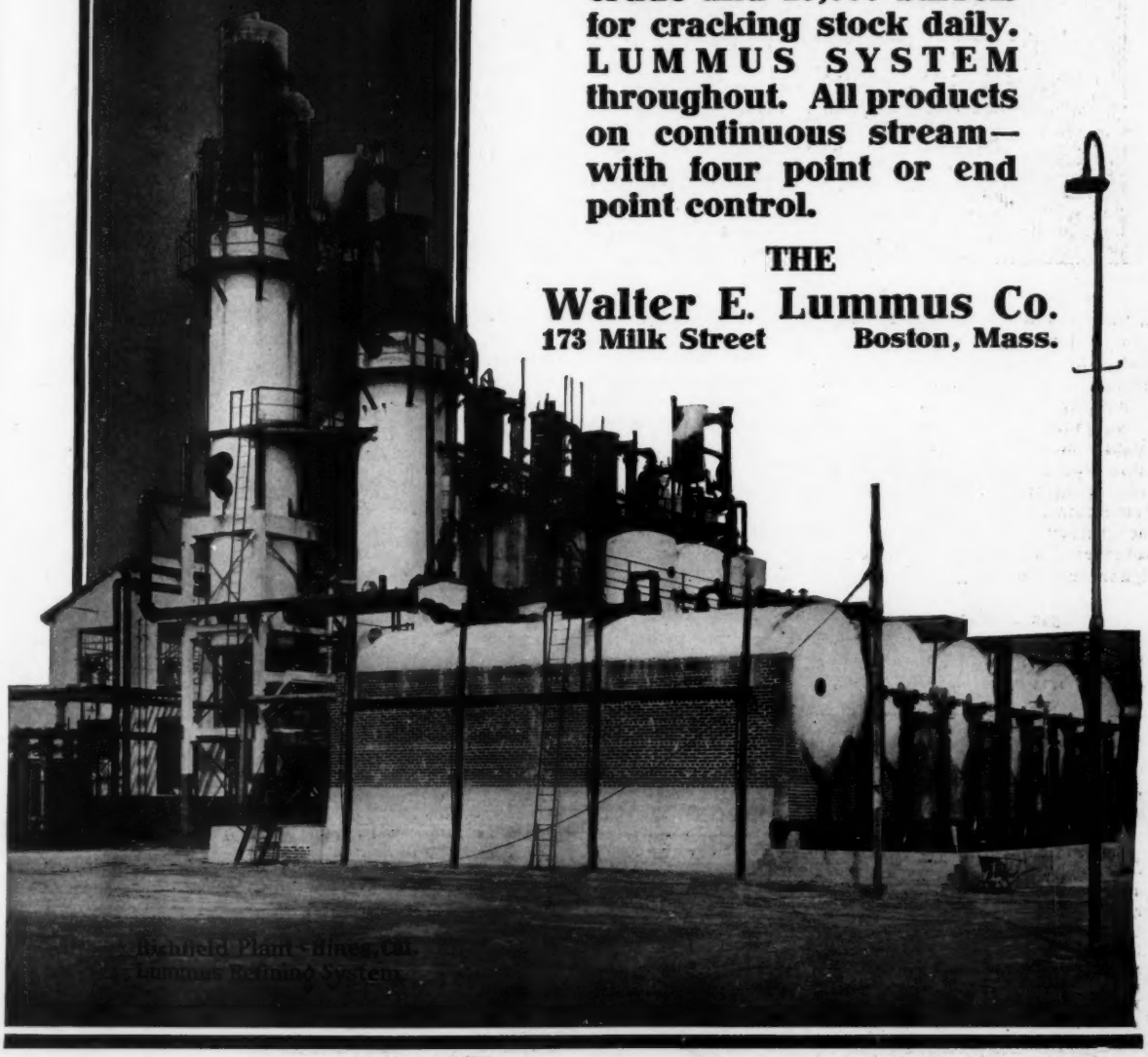

Richfield Plant - Hynes, Cal.
Lummus Refining System

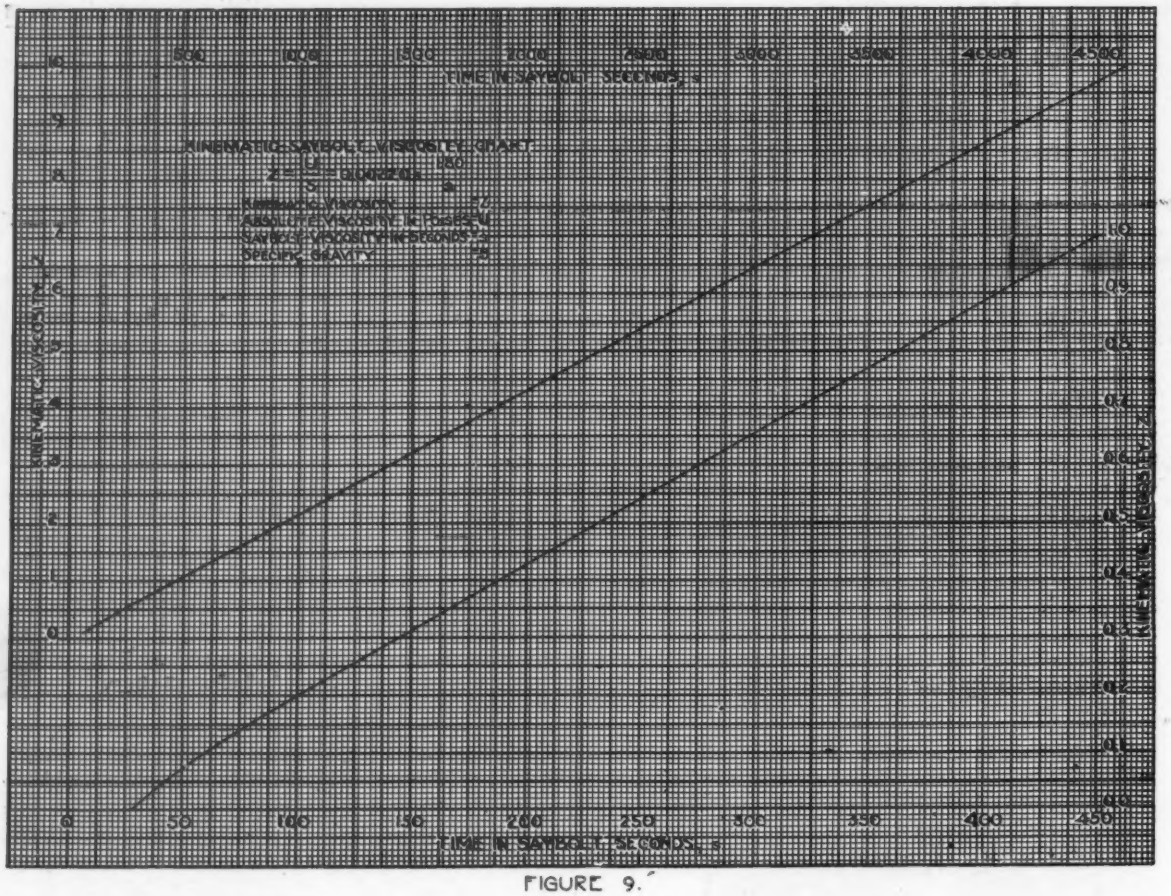
TIME IN SAYBOLT SECONDS, s
KINEMATIC SAYBOLT VISCOSITY CHART
Z = KINEMATIC VISCOSITY
S = SPECIFIC GRAVITY
s = SAYBOLT VISCOSITY IN SECONDS
KINEMATIC VISCOSITY IN POISES, Z
TIME IN SAYBOLT SECONDS, s

FIGURE 9.

of intersection of logarithmic viscosity-temperature graphs:

Base of Crude Oil	Viscosity Centipoises	Temp. °F.
Paraffine	0.38	589
Naphthene	0.76	371

These points were determined from data run at temperatures between 60 and 212 degrees F. Extrapolation for temperatures beyond these limits would be hazardous because it is not known whether this relation is true for a higher or lower range.

Specific Heat of Oils

The specific heat of a substance is defined as the amount of heat necessary to raise the temperature of one pound of the substance through one degree Fahrenheit. Since the specific heat varies with temperature, it becomes necessary to know either the specific heat-temperature relation or the mean specific heat for the operating range.

A review of available literature on this subject reveals little information. What data are obtainable tend to indicate a straight line relation between specific heat and temperature. W. R. Eckart, (Professor of Mechanical Engineering, Stanford University), has found that, for a large number of oils, the specific heat plotted against the absolute temperature gives a straight line passing through the absolute zero.

Figure No. 12 shows the specific heat-temperature relation for three oils. These curves are all straight lines; only one, however, passes through the absolute zero.

The specific heat of a number of petroleum oils and petroleum products is shown in Table No. 4. It will be seen that the specific heat is given for one temperature; or the mean specific heat for a range of temperatures is indicated. A close inspection of these data discloses the fact that the average mean specific heat of a large number of oils is approximately 0.50 B. t. u. per pound per degree F. for temperatures between 32 and 212 degrees Fahrenheit.

Unfortunately, because of lack of ad-

L =Thickness of fluid film—Feet.
M =Hourly equipment charge per B.t.u.—Dollars.
N =Cost of recovering one B.t.u.—Dollars.
O =Time—Hours.
P =Pressure drop through pipe—Pounds/Sq. in. per foot of length.
q =Total heat transferred from body of hot oil to body of cold oil.
q_c =Total heat transferred through film on inside of tube.
q_H =Total heat transferred through film on outside of tube.
q_T =Total heat transferred through metal tube wall.
Q =Total heat transferred in heat exchanger—B.t.u./Hr./Sq. ft./°F.
R =Total resistance to flow of heat=$R_c+R_H+R_T$.
R_c =Internal liquid film resistance to flow of heat.
R_H =External liquid film resistance to flow of heat.
R_T =Metallic resistance to flow of heat.
s =Viscosity—Saybolt Seconds.
S =Specific gravity of fluid—Water=1.
t_1 =Temperature of fat (cold) oil entering—°F.
t_2 =Temperature of fat (cold) oil leaving—°F.
T_1 =Temperature of lean (hot) oil entering—°F.
T_2 =Temperature of lean (hot) oil leaving—°F.
T_a =Temperature of body of hot oil.
T_b =Temperature of film of hot oil at tube surface.
T_c =Temperature of film of cold oil at tube surface.
T_d =Temperature of body of cold oil.
Ø =Logarithmic mean temperature difference (M.T.D.)—°F.
U =Absolute viscosity of fluid—Poises.
V =Velocity of fluid—Feet per minute.
V_c =Critical velocity of flow—Feet per second.
V_s =Velocity of fluid inside of tube—Feet per second.
W =Weight of fluid flowing inside tube—Pounds per second.
W_c =Weight of cold fluid—Pounds per hour.
W_T =Weight of hot fluid—Pounds per hour.
X =Value of one recovered B.t.u.—Dollars.
Y =Hourly profit from heat exchanger—Dollars.
Z =Kinematic viscosity of fluid—Poises.

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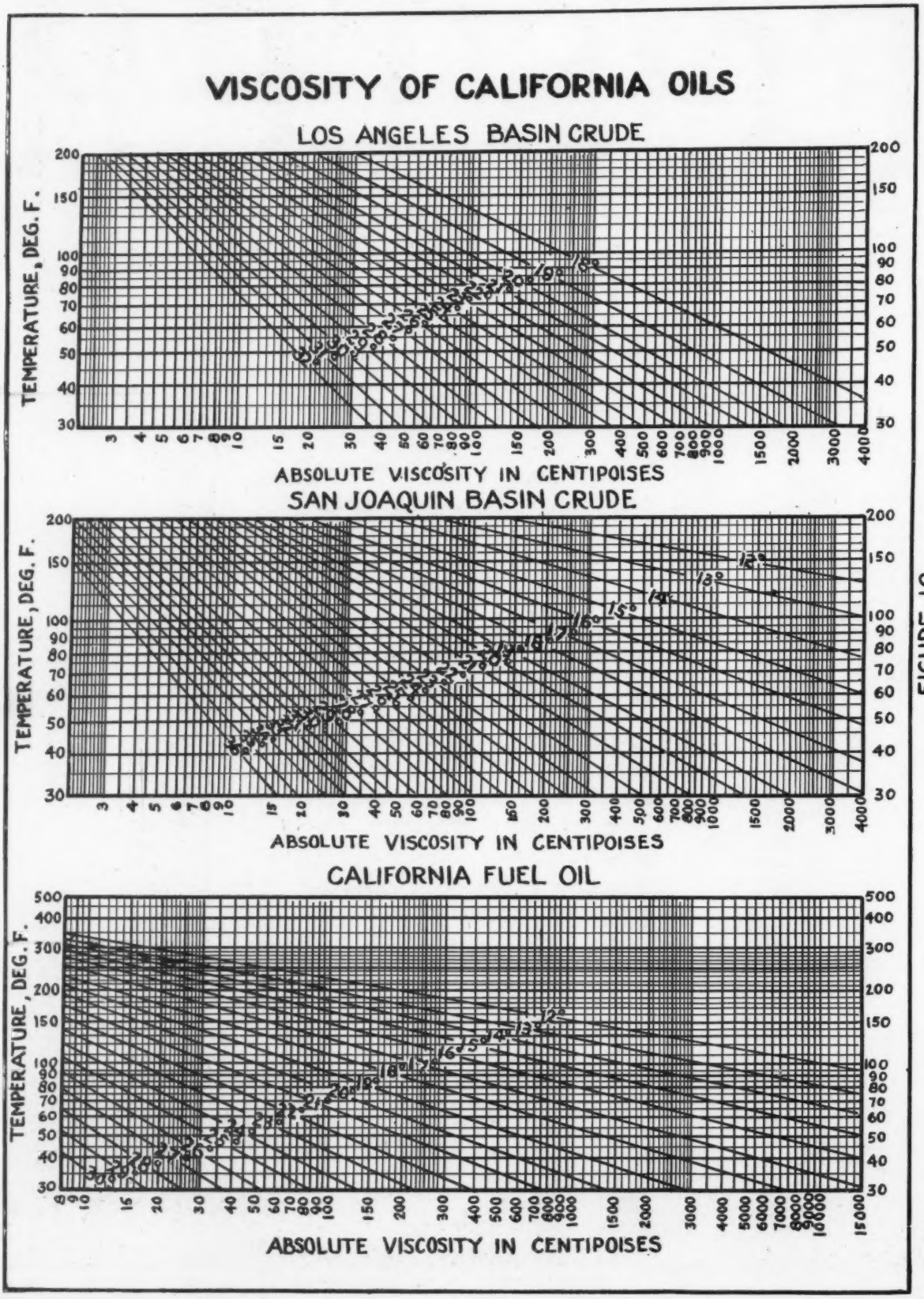
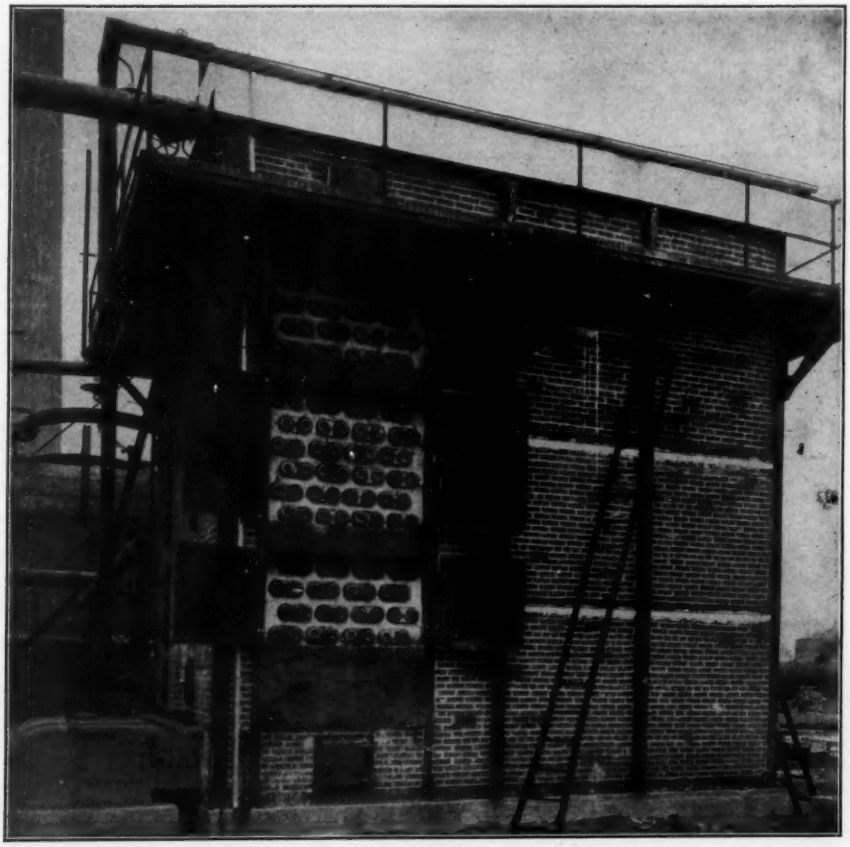

VISCOSITY OF CALIFORNIA OILS
LOS ANGELES BASIN CRUDE
TEMPERATURE, DEG. F.
ABSOLUTE VISCOSITY IN CENTIPOISES
SAN JOAQUIN BASIN CRUDE
TEMPERATURE, DEG. F.
ABSOLUTE VISCOSITY IN CENTIPOISES
CALIFORNIA FUEL OIL
TEMPERATURE, DEG. F.
ABSOLUTE VISCOSITY IN CENTIPOISES

FIGURE 10.

FOSTER

TUBE STILLS



Foster Tube Stills are successfully heating oil to final temperatures as high as 1100 deg. Fahr. without cracking the oil or overheating the heater, and are successfully taking an overhead of 90 per cent of the throughput without cracking.

Performances such as these form one reason for the rapidly increasing number of Foster Tube Still installations—now in excess of 400.

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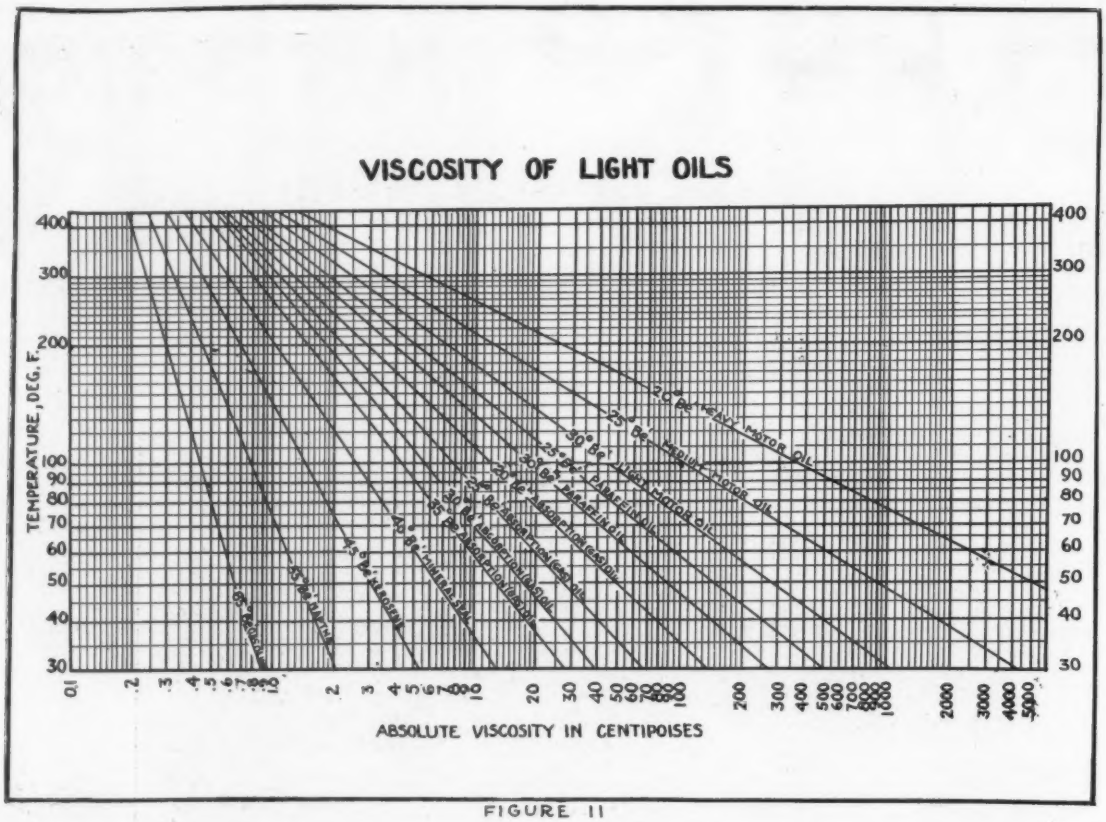


FIGURE 11

equate equipment, the authors were unable to determine the specific heat of all oils used in this investigation. Consequently, for those oils for which the specific heat was not known, the average mean value of 0.50 was assumed. The data given in Table No. 4 justify this assumption.

Computation of Heat Exchanger Problem

The method and procedure for computing the required results from the experimental data may best be explained by quoting an actual example:

Example:

Given: Three exchangers, connected in series, cool 12,900 gallons per hour of 32.2° Be. gravity oil having a viscosity of 42 Saybolt Seconds at 100°F., from 304 to 157°F., with 13,300 gallons per hour of 33.9° Be. gravity oil, having a viscosity of 40.5 Saybolt Seconds at 100°F., which rises in temperature from 84 to 225°F. The 33.9° Be. oil is flowing through 127 ½" standard pipes which are 60 feet in length for each exchanger. The oils are flowing countercurrent to each other in single pass. The tube bundle, made by welding the tubes rigidly into one tube sheet and ferruling into the other, is inserted into a 63 foot length of a 14" O. D. (13.45" I. D.) pipe. The pressure drop through the tubes was 4.2 pounds per square inch and 3.9 pounds per square inch through the shell.

Required: Complete heat transfer analysis, assuming the mean specific heat for both oils to be 0.50 B. t. u. per pound per degree Fahrenheit.

Solution: The total heat transferred is based upon the oil flowing in the tubes for the reason that there are no radiation losses. In this case it depends upon heating 13,300 gallons of 33.9° Be. oil from 84 to 225°F., disregarding the heat required to vaporize the small quantity of light fractions which might have been driven off:

$$Q = 13{,}300 \times 7.127 \times 0.5(225-84) = 6{,}680{,}000 \text{ B. t. u.}$$

The M. T. D. is determined from Figure No. 13.

The L. T. D. is 157—84=73, and the G. T. D. is 304—225=79, from which the M. T. D. is 76°F.

The total mean heating surface is determined with the aid of Table No. 5, from which the mean heating surface is found to be 0.191 square feet per linear foot of pipe. Hence, the mean transfer surface is:

$$A = 0.191 \times 127 \times 60 \times 3 = 4{,}366 \text{ Sq. Ft.}$$

The overall coefficient of heat transfer can now be computed from the data:

$$K = 6{,}680{,}000/4{,}366 \times 76 = 20.2 \text{ B. t. u./Hr./SF./°F.}$$

The mean velocity of the lean oil is determined in the following manner:

$$V_1 = \frac{12{,}900 \times 231}{60 \times 12 \text{ (shell area—external tube area)}}$$

$$= \frac{12{,}900 \times 231}{60 \times 12 \ (142.05 - 69.85)} = 57.2 \text{ Ft./Min.}$$

The mean velocity of the fat oil is computed with the aid of Table No. 5:

$$V_2 = \frac{13{,}300}{60 \times 127} \times 64.2 = 112.0 \text{ Ft./Min.}$$

Attention is called to the fact that in computing the velocities, the change in volume due to temperature is not taken into account.

The mean temperature of the lean and fat oil are determined directly from the inlet and outlet temperatures given, and are found to be 130° and 154°F. respectively.

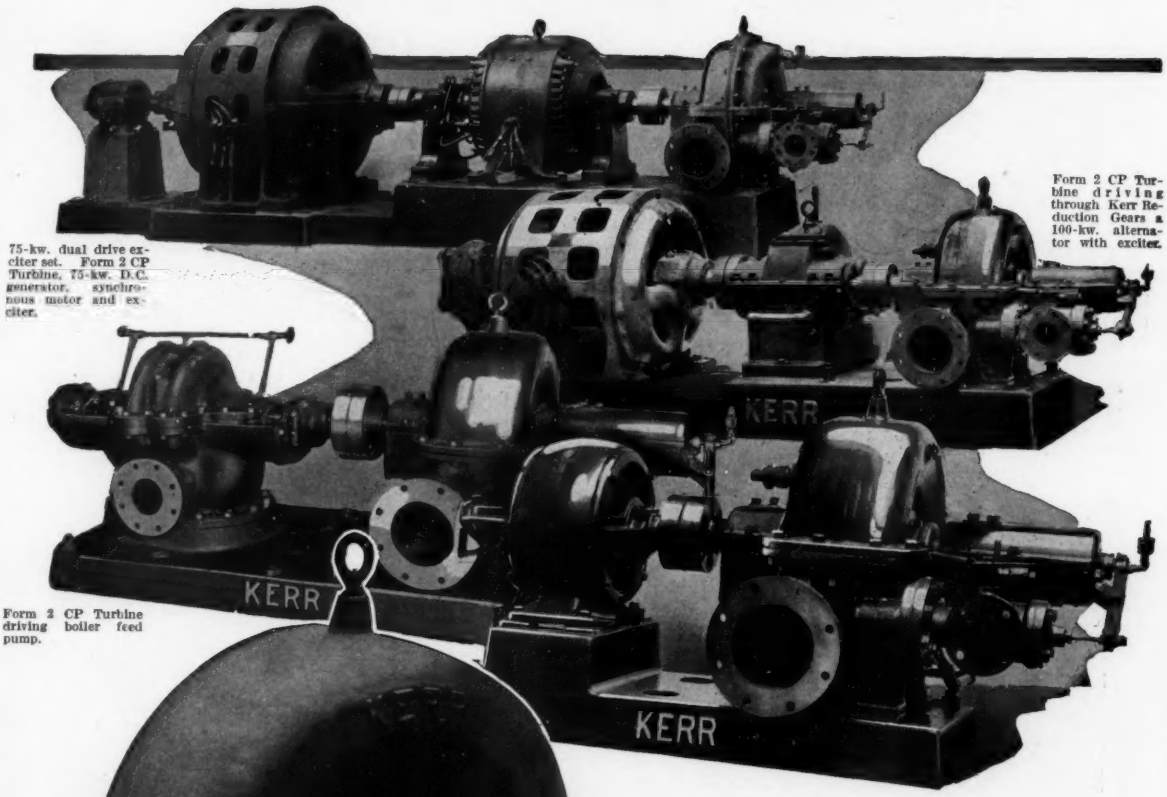
The viscosity of the oils at the mean temperature is determined from the viscosity-temperature curves shown in Figure No. 11. These curves were constructed with data obtained from actual measurements of viscosity at different temperatures. The absolute viscosities are 1.48 and 2.18 centipoises for the lean and fat oil respectively.

The conversion of degrees Be. to specific gravity is simplified by Table No. 6.

The specific gravities at the mean temperature are read directly from Figure No. 14. Following the curve for the specific gravity of th eoil at 60 degrees F. to the point corresponding to the mean temperature, the corrected specific gravity is read on the ordinate scale. The corresponding densities can then be readily determined by multiplying the corrected specific gravities by

KERR "C-P" Turbines

for all classes of service

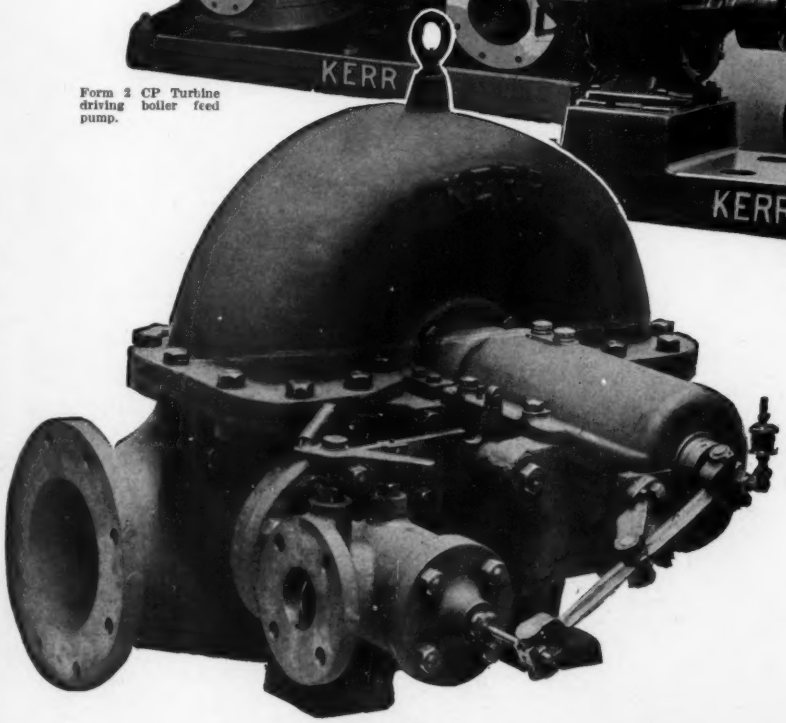


75-kw. dual drive exciter set. Form 2 CP Turbine, 75-kw. D.C. generator, synchronous motor and exciter.

Form 2 CP Turbine driving through Kerr Reduction Gears a 100-kw. alternator with exciter.

Form 2 CP Turbine driving boiler feed pump.

Form 2 CP Turbine direct-connected to 15-kw. D.C. generator.



The applications illustrated show representative uses of the "CP" Mechanical Drive Turbine. With its sturdy construction and its many note-worthy design features, it is well prepared to meet all your requirements for reliable and efficient power in all classes of service.

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H-488

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62.4 the density of water. Following this procedure, the specific gravities are found to be 0.803 and 0.825 with the corresponding densities of 50.10 and 51.50 pounds per cubic foot for the lean and fat oil respectively.

The kinematic viscosity of the fat oil in the tubes is determined from the absolute viscosity and specific gravity. Thus the kinematic viscosity at the mean temperature is:

$$Z_1 = \frac{0.0218}{0.825} = 0.0264 \text{ poises or } 2.64$$

centipoises.

For the lean oil, the kinematic viscosity is:

$$Z_2 = \frac{0.0148}{0.803} = 0.0184 \text{ poises or } 1.84$$

centipoises.

The factor D_2 is an arbitrary figure defined as the thickness of a layer of fluid uniformly distributed over a surface whose length is equal to the sum of the external circumferences of the tubes, so that the cross-sectional area of the fluid is equal to the net area between the shell and the tubes. The value of D_2 for this apparatus is:

$$D_2 = \frac{143.22 - (127 \times 0.55)}{127 \times 2.63} = 0.22 \text{ inch.}$$

D_1, the internal diameter of the tubes, is found from Table No. 5 to be 0.62 inch.

From the values of D_1 and D_2 the ratio of D_1/D_2 is found to be 0.62/0.22 or 2.82. The product of D_1D_2 is:—

$D_1D_2 = 0.22 \times 0.62 = 0.136$.

The above data can now be plotted by suitably combining the appropriate factors. It has been previously explained that the ratio of $K\ D_1/D_2$ is plotted against the result of $D_1D_2V_1V_2\ d_1d_2/U_1U_2$. Therefore:—

$K\ D_1/D_2 = 20.2 \times 2.82 = 57.0$ and

$D_1D_2V_1V_2d_1d_2/U_1U_2 = 0.136 \times 6{,}400 \times 2.580/3.225 = 696{,}000$

Before these data can be plotted it is necessary to determine the state of motion of the liquid in the tubes. Proceeding as later outlined under pressure drop:

$D_1V_2/Z_1 = 0.62 \times 1.866/0.0264 = F = 43.8$

This defines the motion as steady turbulent flow.

The problem of pressure drop through these exchangers is dwelt with under "Fluid Friction Drop."

Fluid Friction Drop

Many attempts have been made to determine the loss of pressure by fluids flowing in pipes. Many formulas, both theoretical and empirical, have been devised which supposedly represented the condition that existed in the experiments undertaken. However, almost all these formulas are applicable only to specific conditions, such as character of fluid, state of flow and diameter of pipe.

The classical work of T. E. Stanton and J. R. Pannell (Philosophical Transaction, Royal Society—Vol. 214, 1914), has shown once and for all that fluid flow obeys definite laws, and that these laws apply to every fluid whether liquid or gas. These laws were devised from experiments performed with commercially smooth drawn tubing, and are assumed to apply to geometrically similar pipes. This means that the roughness or inequalities must be in the same ratio as the pipe diameter.

Fluids flowing in circular pipes reach critical velocities in the same manner as revolving shafts reach critical speeds. The critical velocity of a fluid is accompanied by a change in the state of motion. Below the critical velocity, there exists a state of motion known as stream-line or viscous flow, while above it, the state of motion is known as steady turbulent. Between these two determinable states of flow lies a more or less erratic condition of motion known as unsteady turbulent flow.

The critical velocity manifests itself in a variety of ways. The one outstanding indication is that a consider-

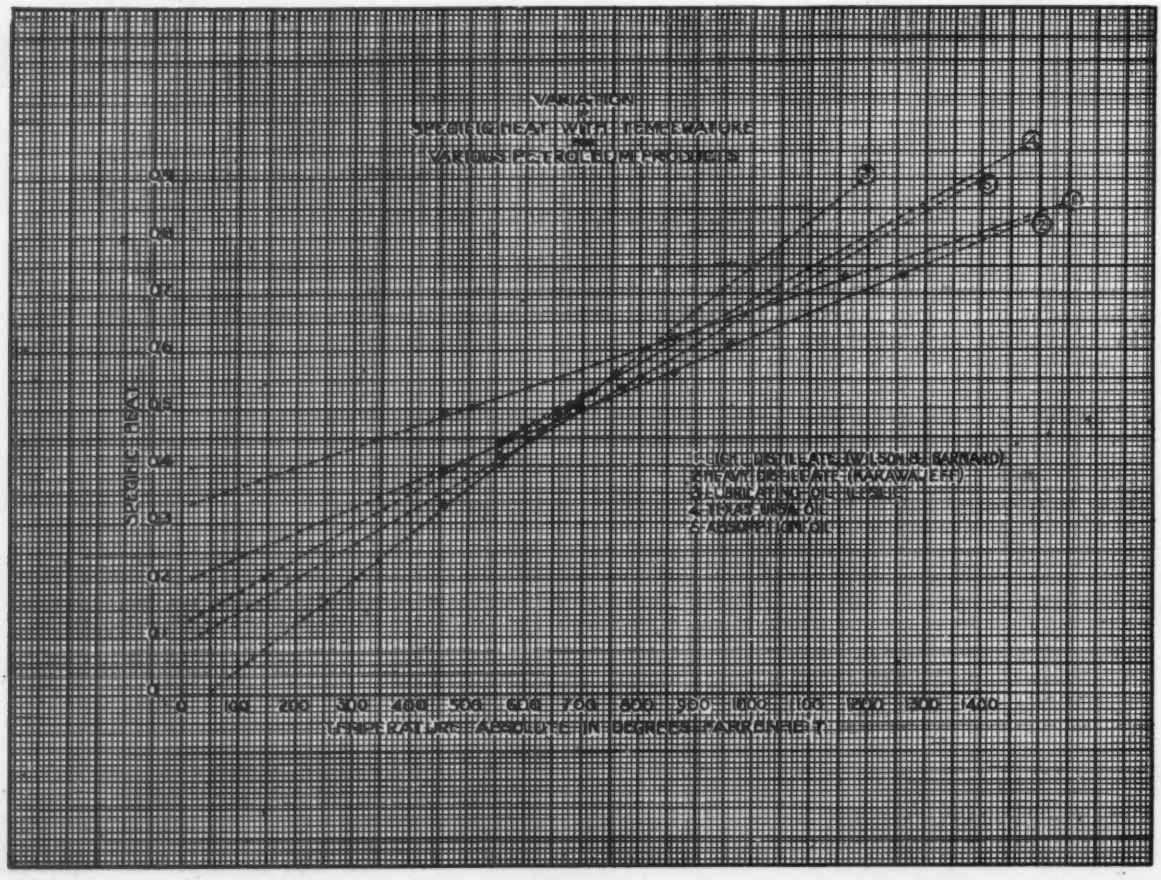
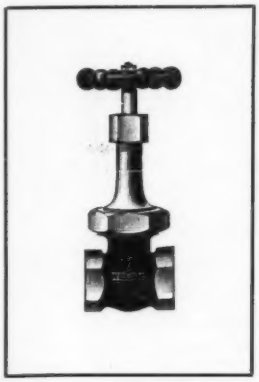
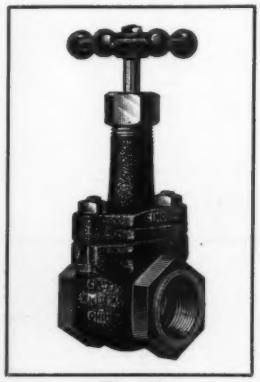


FIGURE 12

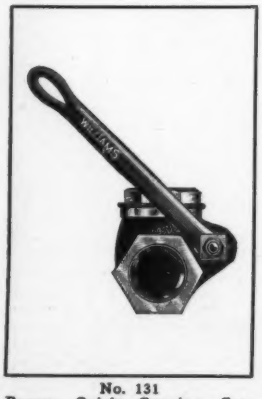
Protect the Vital Points



No. 127
Bronze Gate Valve
For 200 lbs. pressure.
Sizes ¼" to 3"



No. 300
"Cino" Iron Gate Valve
For 125 lbs. pressure.
Sizes ¼" to 3"



No. 131
Bronze Quick Opening Gate Valve
For 200 lbs. pressure.
Sizes ½" to 4"

At hundreds of points valves are the direct guardians of the bank account, standing between the waste of heat, cold and pressures that means precious fuel lost and the leakage of acids, gases or other materials. Among the smallest of equipment in the power and manufacturing plant and fefineries, valves may shut down great boilers, stop machines or processes, hold up production and ruin products —if they fail.

Poor valves are expensive at any price, and good valves are cheap at the highest price.

Williams Valves are the loyal, capable guardians that never fail, never disappoint and are faithful to the service for which each is built.

At thousands of vital points in every kind of industrial plant—on land and sea—Williams Valves are guarding the power, processes and profits of industry.

The name "Williams" on a valve is at once a safeguard against accident, a surety of service and the sign of lowest cost per year of use.

"Williams" is the general guarantee of specific valve service for each valve type we make, one of which fully meets each need in most advanced engineering practice.

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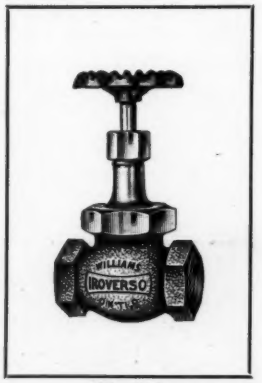
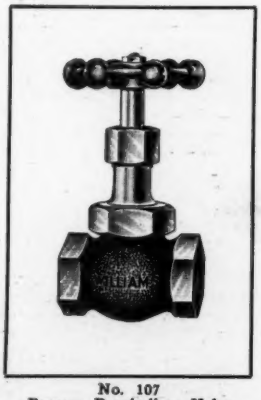
Makers of High Grade Bronze and Iron, Regrinding and Nickel Seat Stop and Check Valves, Gate, Blowoff, Hydraulic, Swing and Ball Check, Needle, Hose, Whistle Valves, Stop and Air Cocks, Unions, Fittings, Water Gauges, Gauge Cocks, Oil Gauges, Lubricators, Oil and Grease Cups, Steam Traps, Separators.

No. 780
"Reverso" Bronze Globe Valve
Reversible Nickel Disc and Seat. For 200 lbs. pressure.
Sizes ¼" to 3"



No. 460
"Iroverso" Iron Globe Valve.
Bronze Mounted Reversible Nickel Disc and Seat.
For 150 lbs. pressure.
Sizes 1½" to 2"



No. 107
Bronze Regrinding Valve
For 200 lbs. pressure
Sizes ⅛" to 3"

Williams Valves

SPECIFIC HEATS OF PETROLEUM OILS.

DESCRIPTION	SPECIFIC GRAVITY AT 60° F.	SPECIFIC HEAT B.T.U. PER LB. / °F.	TEMP. RANGE FOR SPECIFIC HEAT °F	REMARKS	DESCRIPTION	SPECIFIC GRAVITY AT 60°F.	SPECIFIC HEAT B.T.U. PER LB. / °F.	TEMP. RANGE FOR SPECIFIC HEAT °F	REMARKS
RUSSIAN	0.8687	0.5424	32 — 212	CRUDE	CALIFORNIA		0.4804	32 — 212	6.2% ASPHALT
	.8663	.5191					.4832		7.0
	.9079	.4355					.4474		23.5
	.9098	.4988					.4788		30.9
	.9166	.5010					.5016		31.7
	.9185	.4950					.4553		34.7
	.9186	.5020					.4491		35.4
	.9465	.5050					.4419		36.3
JAPANESE	0.8620	0.4530	32 — 212	CRUDE			.4559		39.9
	.8622	.4532				0.9600	.3980		CRUDE
ROUMANIAN	0.8291	0.4724	32 — 212	CRUDE			.4500		
	.8424	.4625			PETROLEUM	0.8000	0.4747	50 — 68	CRUDE
	.8548	.4675					.4903	68 — 96	
	.8694	.4667				.8200	.4766	50 — 68	
GALICIAN		0.5671	230 — 266	CRUDE			.4997	68 — 96	
		.4767	446 — 485			.8800	.5110	70 — 136	
PENNSYLVANIA	0.8095	0.5000	32 — 212	CRUDE	LUBRICATING	0.8650	0.5600	300	
	.8100	.5000					.4000	100	
OHIO		0.4951	32 — 212	CRUDE	NAPTHA	0.7200	0.5687	32 — 212	
TEXAS	0.9200	0.4315	32 — 212	CRUDE		.7527	.5100		
	.9270	.4360	53 — 59	FUEL OIL		.7563	.5710		
	.9456	.4009	32 — 212	CRUDE	GASOLINE	0.6393	0.5800	32 — 212	
WYOMING	0.8816	0.4328	32 — 212	CRUDE		.6420	.5800		
BREA	0.7939	0.4690	32 — 212	CRUDE		.7179	.5697		

TABLE 4.

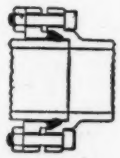
STANDARD PIPE & TUBE DATA — FIGURE

MATERIAL	DIAMETER			THICKNESS		WEIGHT POUNDS PER LIN. FT.	CIRCUMFERENCE		TRANSVERSE AREAS			HEATING SURFACE			VELOCITY		THERMAL CONDUCTIVITY OF METAL B.T.U./HR/SQ FT/°F	COEF. OF LINEAR EXPANSION PER 100° F
	INTERNAL IN INCHES	EXTERNAL IN INCHES	APPROX. INTERNAL INCHES	NO. GAGE B.W.G.	NOMINAL IN INCHES		INTERNAL IN INCHES	EXTERNAL IN INCHES	INTERNAL IN SQ. INS.	EXTERNAL IN SQ. INS.	METAL IN SQ. INS.	SQ. FT. PER OUTSIDE LIN. FT.	SQ. FT. PER INSIDE LIN. FT.	MEAN SQ FT PER LIN. FT.	I-G. P. M. IN FT. PER MIN.	I-FT. PER MIN. IN G.P.M.		
BRASS (60-40),	0.370	½		16	0.065	0.325	1.162	1.571	0.1075	0.1963	0.0888	0.1309	0.0968	0.1138	179.00	0.00558	BRASS	BRASS
COPPER &.	0.402	½		18	0.049	0.260	1.263	1.571	0.1269	0.1963	0.0694	0.1309	0.1052	0.1180	151.60	0.00659	63@63°F	32-212°F
STEEL	0.430	½		20	0.035	0.184	1.351	1.571	0.1452	0.1963	0.0511	0.1309	0.1126	0.1218	132.50	0.00754	COPPER	0.001072
	0.495	⅝		16	0.065	0.421	1.559	1.963	0.1930	0.3068	0.1140	0.1636	0.1299	0.1466	99.78	0.01002	222@64°F	COPPER
	0.509	⅝		17	0.058	0.380	1.598	1.963	0.2040	0.3068	0.1030	0.1636	0.1331	0.1484	94.74	0.01065	220@212°F	32-212°F
	0.527	⅝		18	0.049	0.326	1.660	1.963	0.2180	0.3068	0.0890	0.1636	0.1382	0.1509	88.32	0.01132	STEEL	0.000926
	0.555	⅝		20	0.035	0.238	1.745	1.963	0.2420	0.3068	0.0650	0.1636	0.1455	0.1545	79.68	0.01254	262@64°F	STEEL
	0.620	¾		16	0.065	0.514	1.950	2.356	0.3020	0.4418	0.1400	0.1964	0.1627	0.1793	63.70	0.01570	259@212°F	32-212°F
	0.634	¾		17	0.058	0.464	1.990	2.356	0.3155	0.4418	0.1260	0.1964	0.1660	0.1812	61.14	0.01637		0.00080
	0.652	¾		18	0.049	0.396	2.047	2.356	0.3340	0.4418	0.1080	0.1964	0.1706	0.1836	57.70	0.01732		
	0.680	¾		20	0.035	0.289	2.136	2.356	0.3640	0.4418	0.0780	0.1964	0.1780	0.1872	52.98	0.01888		
	0.870	1		16	0.065	0.700	2.737	3.142	0.5950	0.7854	0.1900	0.2618	0.2279	0.2448	32.40	0.03086		
	0.884	1		17	0.058	0.632	2.775	3.142	0.6135	0.7854	0.1720	0.2618	0.2315	0.2466	31.44	0.03180		
	0.902	1		18	0.049	0.540	2.832	3.142	0.6380	0.7854	0.1470	0.2618	0.2360	0.2490	30.18	0.03310		
	0.930	1		20	0.035	0.389	2.920	3.142	0.6790	0.7854	0.1060	0.2618	0.2433	0.2526	28.44	0.03515		
BOILER TUBE	1.170	1½		8	0.165	2.353	3.676	4.712	1.0751	1.7671	0.6920	0.3920	0.3063	0.3492	17.90	0.05600	262@64°F	0-212°F
	1.204	1½		9	0.148	2.137	3.782	4.712	1.1385	1.7671	0.5286	0.3920	0.3152	0.3536	16.90	0.05910	259@212°F	0.00063
	1.232	1½		10	0.134	1.955	3.870	4.712	1.1921	1.7671	0.5750	0.3920	0.3225	0.3572	16.14	0.06200		
	1.310	1½		13	0.095	1.450	4.115	4.712	1.3480	1.7671	0.4190	0.3920	0.3429	0.3674	14.28	0.07000		
	1.560	1¾		13	0.095	1.680	4.901	5.498	1.9110	2.405	0.4940	0.4582	0.4084	0.4333	10.07	0.09930		
	1.670	2		8	0.165	3.233	5.246	6.283	2.1900	3.1416	0.9520	0.5236	0.4372	0.4804	8.78	0.11400		
	1.704	2		9	0.148	2.927	5.352	6.283	2.2810	3.1416	0.8610	0.5236	0.4461	0.4848	8.44	0.11870		
	1.732	2		10	0.134	2.670	5.441	6.283	2.3560	3.1416	0.7860	0.5236	0.4534	0.4885	8.18	0.12220		
	1.810	2		13	0.095	1.930	5.686	6.283	2.5730	3.1416	0.5690	0.5236	0.4736	0.4987	7.47	0.13400		
	2.782	3		12	0.109	3.370	8.740	9.425	6.0790	7.0690	0.9900	0.7960	0.7280	0.7620	3.16	0.31600		
STANDARD	⅜	0.675	0.490		0.091	0.570	1.550	2.120	0.19	0.36	0.17	0.1770	0.1290	0.1530	101.30	0.00986	349@64°F	32-212°F
WROUGHT IRON	½	0.840	0.620		0.109	0.850	1.950	2.630	0.30	0.55	0.25	0.220	0.1625	0.1910	64.20	0.01560	346@212°F	0.00080
&. STEEL PIPE.	¾	1.050	0.820		0.113	1.130	2.590	3.300	0.53	0.87	0.33	0.275	0.216	0.2460	36.30	0.0276		
	1	1.315	1.050		0.134	1.168	3.290	4.130	0.86	1.36	0.50	0.344	0.274	0.309	22.40	0.0447		
	1¼	1.660	1.380		0.140	2.270	4.340	5.220	1.50	2.16	0.67	0.435	0.361	0.398	12.83	0.0779		
	1½	1.900	1.610		0.145	2.720	5.060	5.970	2.04	2.84	0.80	0.498	0.422	0.460	9.44	0.1060		
	2	2.375	2.070		0.154	3.650	6.490	7.460	3.36	4.43	1.07	0.622	0.541	0.582	5.73	0.1744		
	2½	2.875	2.470		0.204	5.790	7.750	9.030	4.78	6.49	1.71	0.753	0.645	0.699	4.02	0.2486		
	3	3.500	3.070		0.217	7.570	9.630	11.000	7.39	9.62	2.24	0.917	0.800	0.858	2.60	0.3847		
	4	4.500	4.030		0.237	10.790	12.650	14.140	12.73	15.90	3.16	1.178	1.052	1.115	1.51	0.6620		
	5	5.563	5.050		0.259	14.620	15.850	17.480	19.99	24.31	4.32	1.450	1.317	1.384	0.96	1.0380		
	6	6.625	6.070		0.280	18.970	19.050	20.810	28.89	34.47	5.59	1.725	1.588	1.656	0.66	1.5000		
	7	7.625	7.020		0.301	23.540	22.060	23.960	36.74	45.66	6.92	2.000	1.853	1.926	0.49	2.0150		
	8	8.625	8.070		0.276	24.690	25.350	27.100	51.15	58.43	7.28	2.270	2.130	2.200	0.38	2.6600		
	8	8.625	7.980		0.322	28.550	25.070	27.100	50.02	58.43	8.41	2.270	2.085	2.178	0.39	2.6000		

NOTE:- FOR WT. OF COPPER, MULTIPLY WT. OF BRASS BY .965, FOR STEEL, BY 0.92

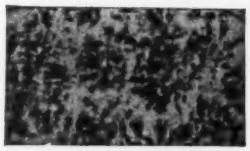
TABLE 5.

SIMPLEX CAST IRON CONDENSER PIPING

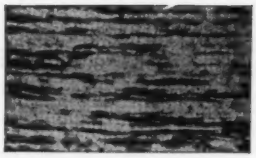


"ONE FLANGE IS LOOSE"

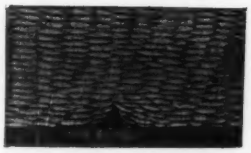
COATS ITSELF



Photomicrograph of cast iron, much enlarged, showing granular structure.



Photomicrograph of wrought iron, much enlarged, showing fibrous structure.



A piece of sheet steel, much enlarged, showing surface and sectional structure with a typical pit.

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Scientists believe this phenomena due to the microscopic structure of cast iron —a structure of the same granular or crystalline form as found in the iron ore from which it is made and which has laid unimpaired in the ground for untold centuries. Cast iron rusts on the surface, but the corrosive agent fails to break the natural mechanical bond between the irregular shaped granules, further oxygen is excluded by the first rust coating, and therefore corrosion stops. Cast iron literally coats itself.

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able increase in pipe line pressure does not result in a corresponding increase of discharge. This is the condition of unsteady turbulent or unstable flow and at this point the whirls and eddies formed do not take on any systematic conformation. However, a further increase in pressure results in a proportionate increase in the discharge, the liquid now having reached a new state of equilibrium called steady turbulent flow. At the condition of steady flow, the pressure and velocity at any one point in the line remain constant at all times. The important feature existing in fluid flow is that the rate increase of frictional loss, as the velocity increases, is less when the critical velocity has been exceeded than below the critical velocity.

The critical velocity of a fluid is given by the equation:

$V_c = F\ Z_1/D_1$

where V_c=Critical velocity..Ft. per sec.
D_1=Inside diameter of tube.. ..... Inches
Z_1=Kinematic viscosity of fluid ..... Poises.
F=A constnat.

The critical velocity is therefore directly proportional to the kinematic viscosity. It is evident that for large values of Z_1 such as are found for heavy cold oils V_c becomes so large that an effort to exceed the critical velocity would involve high pumping pressures and excessive frictional drops.

Where Z_1 is small, as in the case of heated oils, V_c is also small and velocities in excess of the critical velocity are permissible due to reasonable frictional losses in the tubes under these conditions.

A convenient method for determining the critical velocity follows:

The critical velocity range begins when,

$D_1V_c/Z_1 = 25$ or $V_c = 25\ Z_1/D_1$

and ends when,

$D_1V_c/Z_1 = 40$ or $V_c = 40\ Z_1/D_1$.

It therefore follows that stream-line flow exists for values of D_1V_c/Z_1 less than 25 and steady turbulent flow for values greater than 40, where V_c is the velocity in feet per second.

Where the operating range of temperature varies considerably, as in heat exchangers, it will be found that for a given velocity, more than one state of flow may exist in the apparatus. This is due to the change in the kinematic viscosity of a fluid with temperature. Pumping equipment must therefore be selected to provide sufficient pressure to produce velocities in excess of the critical velocity corresponding to the highest kinematic viscosity.

Pressure loss due to friction is expressed by the general equation:

$P = C\ W^2/d_1D_1^5$

where P=Pressure loss per foot of length ....Lbs. per sq. in.
W=Weight of fluid flowing.. .....Lbs. per sec.
d_1=Density of fluid..... .....Lbs. per cu. ft.
D_1=Inside diameter of pipe ..... Inches
U_1=Absolute viscosity of fluid ..... Poises.
C=A coefficient depending upon W, D_1 and U_1.

Figure No. 15 gives values of C both below and above the critical velocity plotted against the ratio W/D_1U_1. Between the values of 8 to 14 for W/D_1U_1 the curve has not been plotted, since between these limits, unstable flow conditions prevail.

The curves and formulas given here are based upon the smooth drawn tubing and apply to geometrically similar pipes. This means that the roughness or inequalities must be in the same ratio as the pipe diameter.

When the inequalities are in a greater ratio, the curves will be correspondingly higher. The case of oil exchangers more nearly approximate this latter condition when using standard pipe tubes. The authors have found that actual pressure losses in heat exchangers are two to two and one-half times those computed by the foregoing curves and formulas. However, the pressure drop through an exchanger, as determined by actual measurement, includes several entrance and discharge losses which the curves and formulas do not take into account. The difficulty of accurately expressing the roughness of the tube surfaces limits the application of these curves and formulas, except where modifying factors have been experimentally determined. These modifying factors should include the entrance and discharge losses.

Table No. 7 shows the variation between the experimentally determined pressure drop and the corresponding computed figure. The experimentally determined drop includes all frictional losses from the inlet to the outlet of the exchanger.

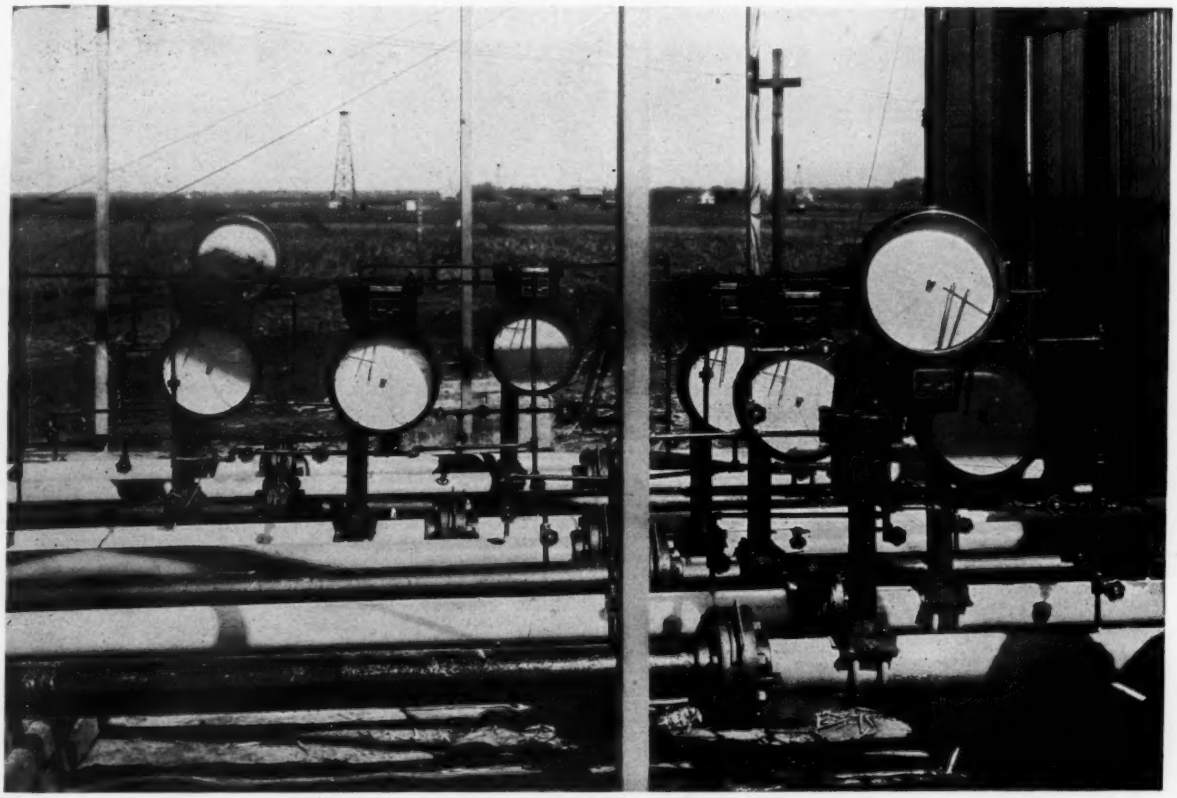
The application of the curves and formulas will be explained by an example taken from practice:

Problem: To find the pressure drop through three single-pass tubular heat exchangers operated in series, each having 127 ½" standard pipe tubes 60 feet long, when handling 13,300 gallons per hour of 33.9° Be. gravity absorp-

BAUME, SPECIFIC GRAVITY, DENSITY & COEFFICIENT OF EXPANSION OF AMERICAN PETROLEUM OILS

DEG. BAUME	U.S. BUREAU OF STANDARDS		A.P.I.		CHANGE IN SP. GRV PER DEG. F.	DEG. BAUME	U.S. BUREAU OF STANDARDS		A.P.I.		CHANGE IN SP. GRV PER DEG. F
	SPECIFIC GRAVITY	POUNDS PER GALLONS	SPECIFIC GRAVITY	POUNDS PER GALLONS			SPECIFIC GRAVITY	POUNDS PER GALLONS	SPECIFIC GRAVITY	POUNDS PER GALLONS	
10.0	1.0000	8.325	1.0000	8.331	.00035	30.0	0.8750	7.286	0.8762	7.300	.00036
10.5	.9964	8.299	.9965	8.302	.00035	30.5	.8723	7.264	.8735	7.277	.00037
11.0	.9929	8.269	.9930	8.273	.00035	31.0	.8696	7.241	.8708	7.255	.00037
11.5	.9894	8.240	.9895	8.244	.00035	31.5	.8669	7.218	.8681	7.232	.00037
12.0	.9859	8.211	.9861	8.215	.00035	32.0	.8642	7.196	.8654	7.210	.00037
12.5	.9825	8.182	.9826	8.186	.00035	32.5	.8615	7.173	.8626	7.188	.00037
13.0	.9790	8.153	.9792	8.158	.00035	33.0	.8589	7.152	.8602	7.166	.00037
13.5	.9756	8.125	.9759	8.130	.00035	33.5	.8563	7.130	.8576	7.145	.00037
14.0	.9722	8.096	.9725	8.102	.00035	34.0	.8537	7.108	.8550	7.123	.00037
14.5	.9688	8.069	.9692	8.074	.00035	34.5	.8511	7.087	.8524	7.104	.00037
15.0	.9655	8.041	.9659	8.047	.00035	35.0	.8485	7.065	.8498	7.080	.00037
15.5	.9622	8.013	.9626	8.019	.00035	35.5	.8459	7.044	.8473	7.059	.00037
16.0	.9589	7.986	.9593	7.992	.00035	36.0	.8434	7.022	.8446	7.036	.00037
16.5	.9556	7.959	.9561	7.965	.00035	36.5	.8408	7.001	.8423	7.017	.00037
17.0	.9524	7.931	.9529	7.939	.00035	37.0	.8383	6.980	.8398	6.996	.00037
17.5	.9492	7.904	.9497	7.912	.00035	37.5	.8358	6.960	.8373	6.976	.00037
18.0	.9459	7.877	.9465	7.885	.00035	38.0	.8333	6.939	.8348	6.955	.00036
18.5	.9428	7.851	.9433	7.859	.00035	38.5	.8309	6.918	.8324	6.935	.00036
19.0	.9396	7.825	.9402	7.833	.00035	39.0	.8284	6.898	.8299	6.914	.00036
19.5	.9365	7.799	.9371	7.807	.00035	39.5	.8260	6.877	.8275	6.894	.00036
20.0	.9333	7.772	.9340	7.781	.00036	40.0	.8235	6.857	.8251	6.874	.00036
20.5	.9302	7.747	.9309	7.755	.00036	40.5	.8211	6.837	.8227	6.854	.00039
21.0	.9272	7.721	.9279	7.730	.00036	41.0	.8187	6.817	.8203	6.834	.00039
21.5	.9241	7.696	.9248	7.705	.00036	41.5	.8163	6.797	.8179	6.814	.00039
22.0	.9211	7.670	.9218	7.680	.00036	42.0	.8140	6.777	.8156	6.795	.00039
22.5	.9180	7.645	.9188	7.655	.00036	42.5	.8116	6.756	.8132	6.775	.00039
23.0	.9150	7.620	.9159	7.630	.00036	43.0	.8092	6.736	.8109	6.756	.00039
23.5	.9121	7.595	.9129	7.605	.00036	43.5	.8069	6.718	.8086	6.736	.00039
24.0	.9091	7.570	.9100	7.581	.00036	44.0	.8046	6.699	.8063	6.717	.00039
24.5	.9061	7.546	.9071	7.557	.00036	44.5	.8023	6.680	.8040	6.698	.00039
25.0	.9032	7.522	.9042	7.533	.00036	45.0	.8000	6.661	.8017	6.679	.00039
25.5	.9003	7.497	.9013	7.509	.00036	45.5	.7977	6.642	.7994	6.660	.00039
26.0	.8974	7.473	.8984	7.485	.00036	46.0	.7955	6.623	.7972	6.641	.00039
26.5	.8946	7.449	.8956	7.461	.00036	46.5	.7932	6.604	.7949	6.623	.00040
27.0	.8917	7.425	.8927	7.437	.00036	47.0	.7910	6.586	.7927	6.604	.00040
27.5	.8889	7.402	.8899	7.414	.00036	47.5	.7887	6.567	.7905	6.586	.00040
28.0	.8861	7.378	.8871	7.390	.00036	48.0	.7865	6.548	.7883	6.567	.00040
28.5	.8833	7.355	.8844	7.378	.00036	48.5	.7843	6.530	.7861	6.549	.00040
29.0	.8805	7.332	.8816	7.345	.00036	49.0	.7821	6.511	.7839	6.531	.00041
29.5	.8777	7.309	.8789	7.322	.00036	49.5	.7799	6.494	.7818	6.513	.00041

TABLE 6.



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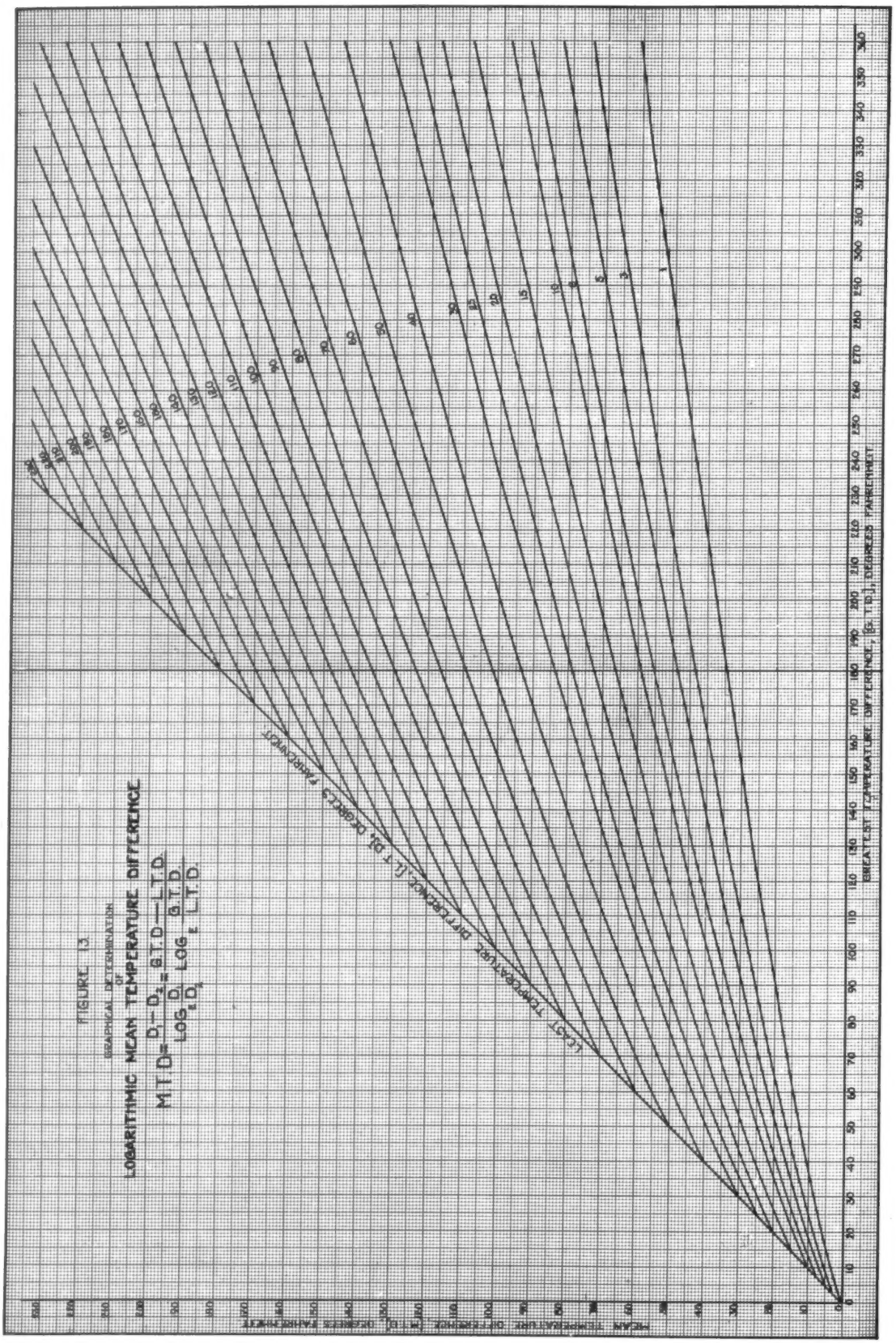
FIGURE 13
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Table No. 7—Variation Between Experimental and Computed Pressure Drops

Diam. of Tube D_1 "	Length of Tube L '	Viscosity of Oil U_1 P.	Velocity of Oil V_s '/sec.	Density of Oil $d_1$pf3	Weight of Oil W lb/sec.	C	Pressure Drops Comptd. pi2	Expermt. pi2
0.62	60	0.0168	1.754	50.70	0.1950	1.75	0.85	1.40
0.62	180	0.0212	1.760	51.45	0.1885	1.87	2.54	2.80
0.62	180	0.0220	2.104	51.50	0.2255	1.80	3.50	5.00
0.402	20	0.0475	2.034	52.25	0.0936	2.45	0.95	3.00
2.47	3330	0.0410	2.000	52.50	3.4900	1.47	12.33	28.00

tion oil. The oil has a viscosity of 40.5 Saybolt Seconds at 100°F., and is raised in temperature from 84 to 225°F.

Solution: The average temperature of the oil is 154°F. Specific gravity of 33.9° Be. oil at 60°F. is 0.8555. Density of 33.9° Be. oil at 60°F. is 53.35 lbs. per cu. ft. Internal diameter of ½-inch standard pipe is 0.62 inch. Internal area of ½-inch standard pipe is 0.30 sq. in. The mean velocity of the oil through the tubes is:

$$V_s = \frac{13{,}300 \times 231}{127 \times 60 \times 60 \times 12 \times 0.3} = 1.866 \text{ ft. 1 sec.}$$

The weight of oil flowing through the tubes is:

$$W = \frac{12 \times 1.8666 \times 0.30 \times 53.35}{1{,}728} =$$

0.208 lbs./sec.

The absolute viscosity of 40.5 Saybolt Seconds, 33.9° Be. oil, is found from Figure No. 9. The kinematic viscosity corresponding to 40.5 Saybolt Seconds is 0.046 poises. The specific gravity is 0.8555 at 60°F. and hence (Fig. 14) 0.8420 at 100°F. The absolute viscosity is therefore 0.046/0.842 or 0.0547 poises at 100°F. The viscosity-temperature curve for this class of oil gave an absolute viscosity of 0.0218 poises at 154°F.

Now solving for W/D_1V_1 we get 15.40 and from Figure No. 15 we find this corresponds to a value for C of 1.83. The density of the oil at 154°F. is found by means of Figure No. 14.

Solving for the pressure drop:

$$P = C\frac{W^2}{dD^5} = \frac{1.83 \times (0.208)^2}{51.50 \times (0.62)^5} \times 180$$

=3.02 Lbs. per sq. in.

The pressure drop through this exchanger was found by actual measurement to be 4.20 lbs. per sq. in. A correction factor of one and one-half would have been ample in this case. The pressure drop through the shell for a flow of 12,900 gallons per hour of 32.2° Be. gravity oil having a viscosity of 42 Saybolt Seconds at 100°F. was found by measurement to be 3.90 lbs. per sq. in.

Economic Design of Heat Exchangers

It has been shown that the transfer of heat is a direct function of the velocity of flow. High velocity, therefore, gives high heat transfer rates and consequently reduces equipment expenses. However, since friction loss is also a direct function of the velocity, the increasing of the velocity beyond a maximum point results in pumping costs in excess of the value of the additional heat transferred. Furthermore, the amount of heat transferred increases as the surface is increased, but not in direct proportion, because as the temperature of the two fluids approach each other, the quantity of heat transferred through each increment of area becomes less. The cost of additional equipment, including the additional pumping charges, maintenance, etc., increases approximately in proportion to the increase in surface. Therefore, a point is reached, beyond which it is not economical to go, because the additional heat saved by increasing the surface beyond this point will not net a reasonable profit. The necessity of choosing velocities and transfer areas

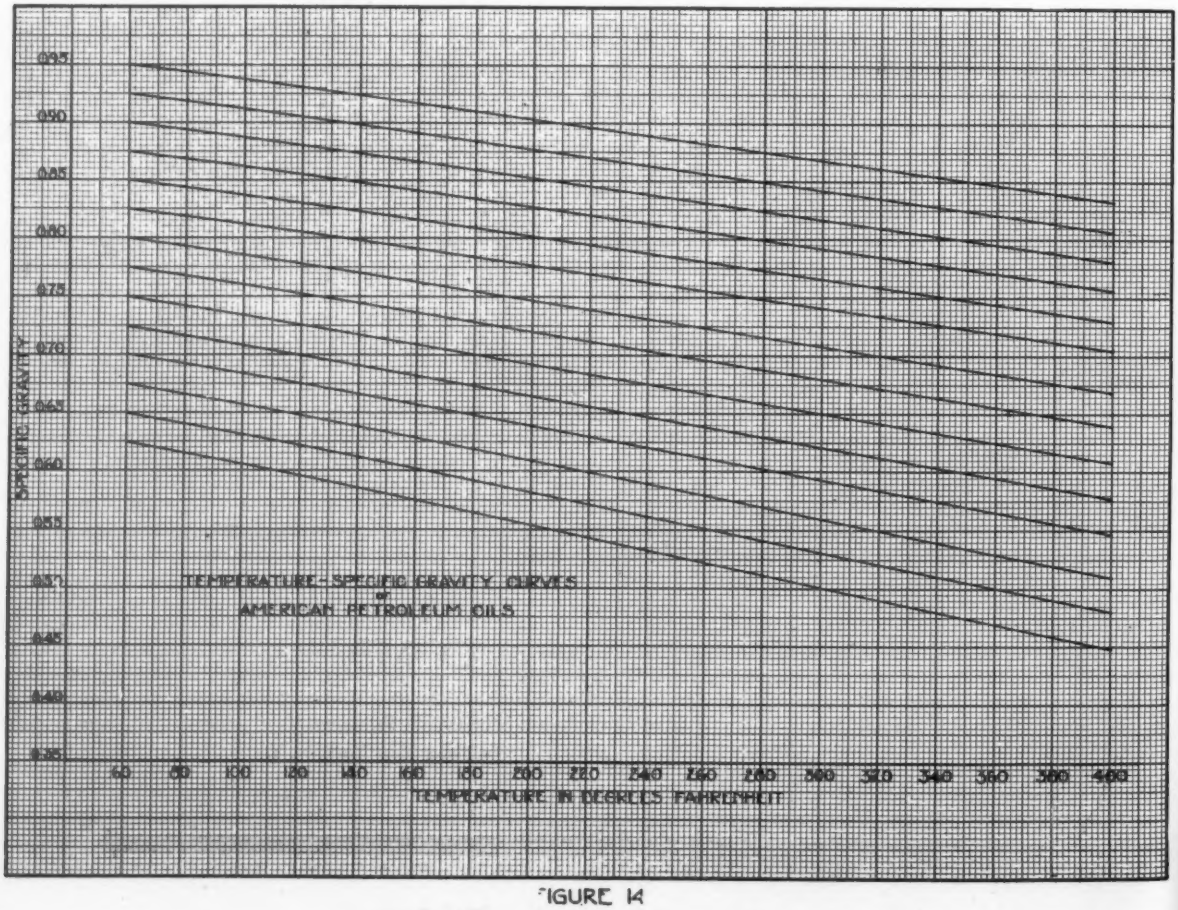
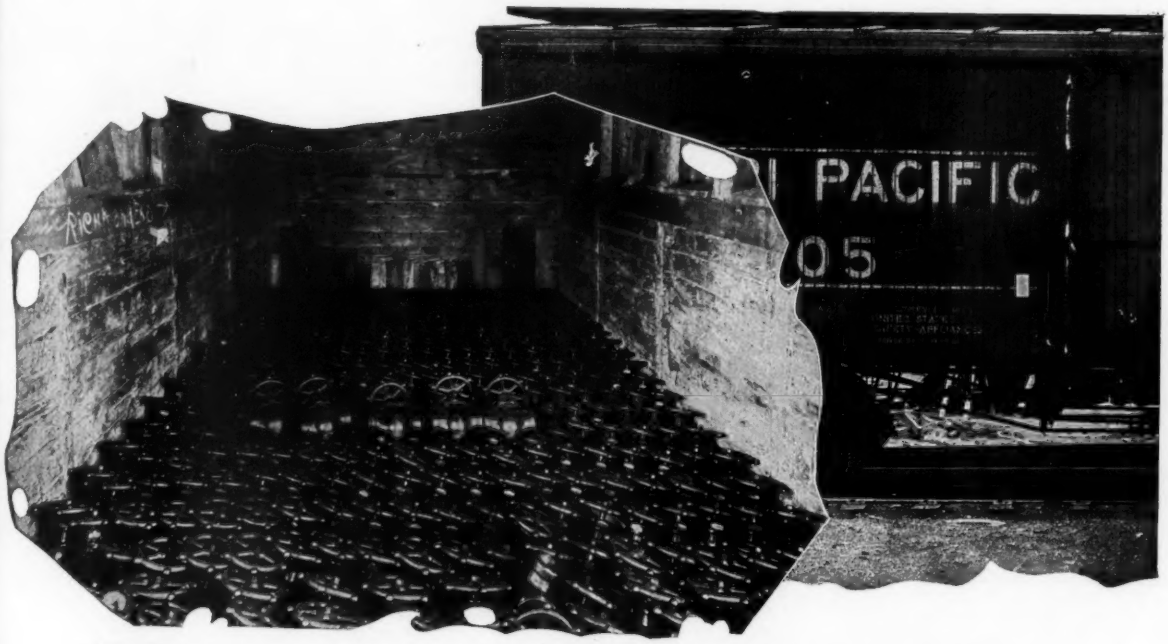
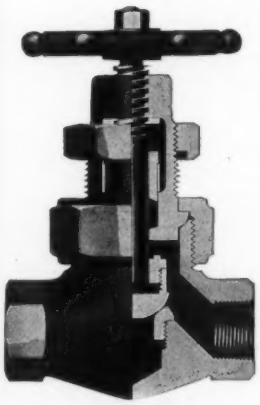


FIGURE 14



Here's *A* Carload~



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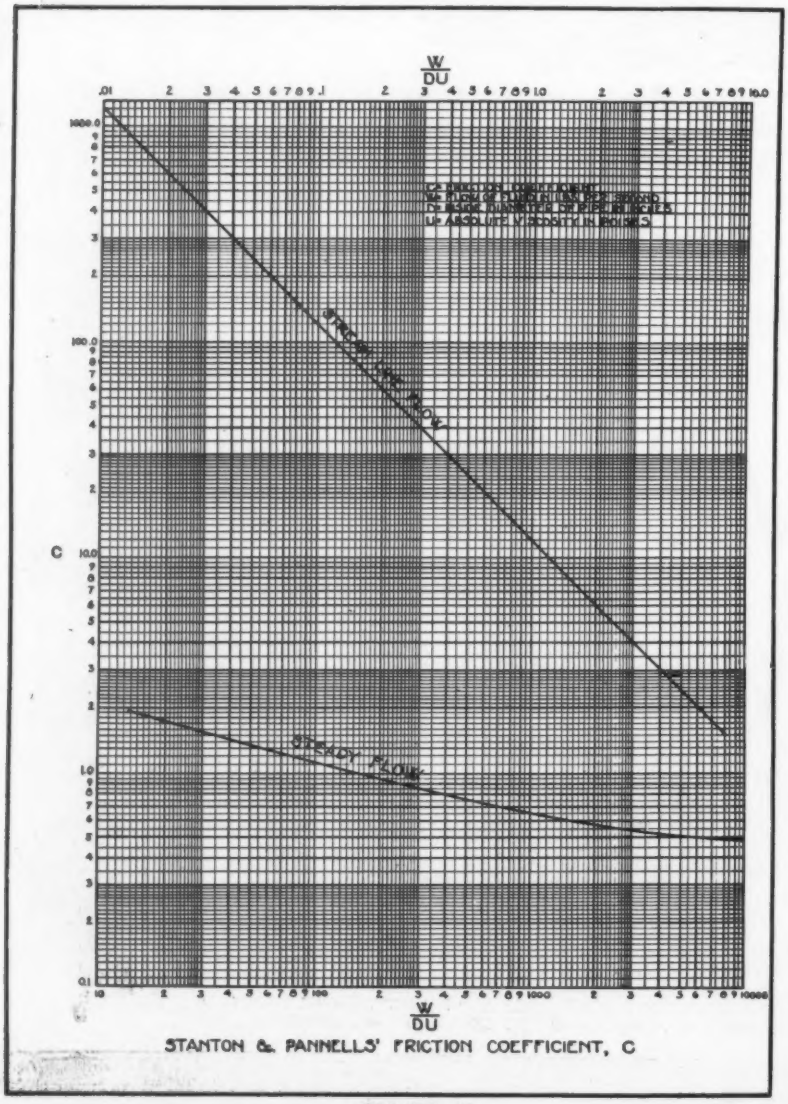
to secure a proper economic balance between installation and operating costs, is, therefore, apparent.

The determination of the optimum economic velocity and transfer area has hitherto been accomplished by laborious graphical methods. When complete data are available, a more simplified method is the derivation of formulas which will give the desired results directly. Unfortunately, this can be accomplished only in part because of lack of information.

The selection of the velocity of a fluid will be governed by the friction drop and the heat transfer coefficient; the one balanced against the other. Numerous empirical equations have been proposed for the relation between friction drop and velocity. However, the relation between the heat transfer coefficient and velocity, even though it depends upon the same factors, is of a more complex nature. For this reason, no mathematical solution of this phase of the problem will be attempted.

It has already been made clear that high heat transfer rates accompany turbulent flow. Unsteady turbulent flow produces proportionately high friction losses, so that it is advisable to choose velocities which produce steady turbulent motion. The minimum velocity should, therefore, be such that $V_s D_1/Z_1$ is equal to or greater than 40. Engineering judgment must govern the selection of velocities greater than the minimum mentioned, if excessive pumping costs are to be eliminated.

A decision must be made as to the type of heat exchanger to be constructed. Assuming an oil of known characteristics and the selected velocity, the corresponding heat transfer coefficient can be determined directly from the curves of Figures Nos. 6, 7 and 8. This coefficient (K) will be presently used in determining the transfer area required.



STANTON & PANNELLS' FRICTION COEFFICIENT, C

FIGURE 15.

The total heat transferred depends upon the transfer area as one factor. It was mentioned before that as the temperature of the two liquids approach each other, the heat transferred through each increment of area becomes less. A point is reached where the value of the heat saved is less than the fixed charges on the additional equipment necessary to effect the saving. The determination of the maximum economical heat transferable is accomplished by the following method:

Let $\frac{W_T c_T}{W_t c_t} = J$ (which is less than 1) ..... (1)

(The case of $W_T c_T$ less than $W_t c_t$ is considered. The procedure is similar if the reverse were true.)

and $E = \frac{T_1 - T_2}{T_1 - t_1}$ = Efficiency of transfer ..... (2)

The maximum heat transferable per hour is,

$Q_T = W_T c_T (T_1 - t_1)$ ..... (3)

The heat actually transferred per hour is,

$$Q = W_T c_T (T_1 - T_2 = \frac{KA (T_1 - t_2 - (T_2 - t_1)}{\log_e \frac{(T_1 - t_2)}{(T_2 - t_1)}} \quad (4)$$

Let the total hourly cost, including both power and equipment charges, be M dollars per square foot of heating surface. The total hourly charge against the whole equipment is therefore MA, whence the cost per B. t. u. recovered is:

$$N = \frac{M}{K(T_1 - t_2) - (T_2 - t_1)} \times \log_e \frac{(T_1 - t_2)}{(T_2 - t_1)} \quad \ldots\ldots\ldots\ldots (5)$$

Let the value of a recovered B. t. u. be X, which is the cost of a B. t. u. as added directly in subsequent operations. (If the fluid cooling must be further cooled in a separate exchanger, the cost of removing a B. t. u. in that unit should be included in X.)

The hourly profit is, therefore:

$$Y = XW_T c_T (T_1 - T_2) - \frac{MW_T c_T (T_1 - T_2)}{K((T_1 - t_2) - (T_2 - t_1))} \times \log_e \frac{(T_1 - t_2)}{(T_2 - t_1)} \quad (6)$$

from (1) and (2),

$$\log_e \frac{(T_1 - t_2)}{(T_2 - t_1)} = \log_e \frac{(1 - EJ)}{(1 - E)}$$

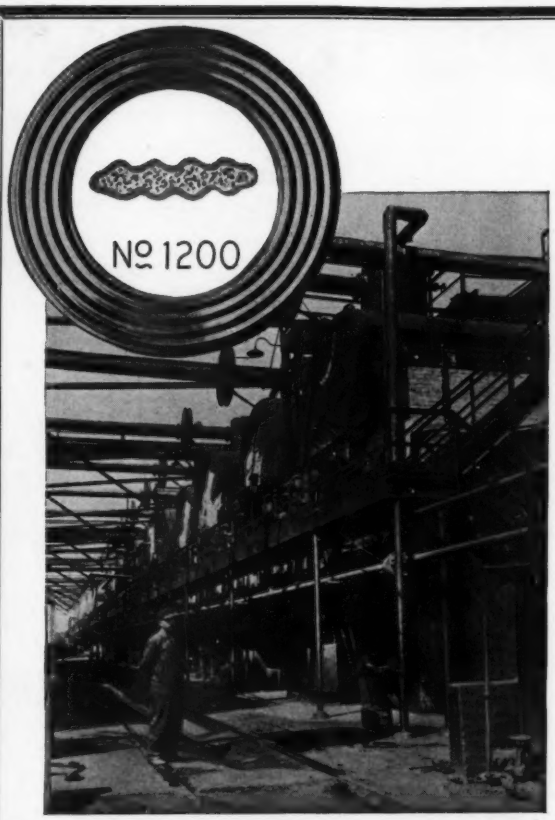
and

$$\frac{(T_1 - T_2}{(T_1 - t_2) - (T_2 - t_1)} = \frac{1}{(1 - J)}$$

Substituting for E its equivalent and simplifying,

$$Y = XW_T c_T (T_1 - T_2) - \frac{MW_T c_T}{K(1 - J)} \times \log_e \frac{((T_1 - t_1) - J(T_1 - T_2))}{(T_2 - t_1)} \quad (7)$$

The hourly profit should be made a maximum by properly selecting the



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The design of the EMPIRE is entirely different from that of any other type of oil meter. The construction of the measuring unit is such that what wear occurs is easily taken up by a very simple and inexpensive readjustment, and the meter is then once again in practically as good condition as when it first left the factory.

It is this feature of LASTING accuracy that sets the EMPIRE apart in a class by itself as a reliable measuring device. Every branch of the petroleum industry can be served by EMPIRE meters. They are made in both standard and high pressure types. We also make special types. Consult us freely as to your particular requirements.

EMPIRE METERS ARE MADE IN ALL SIZES FROM 5/8″ to 6″ INCLUSIVE

Send postal for fully illustrated descriptive circular No, 110-R

NATIONAL METER COMPANY

299 Broadway, New York

CHICAGO BOSTON CINCINNATI ATLANTA SAN FRANCISCO LOS ANGELES

NEW EQUIPMENT, CATALOGS, BULLETINS, BOOKS

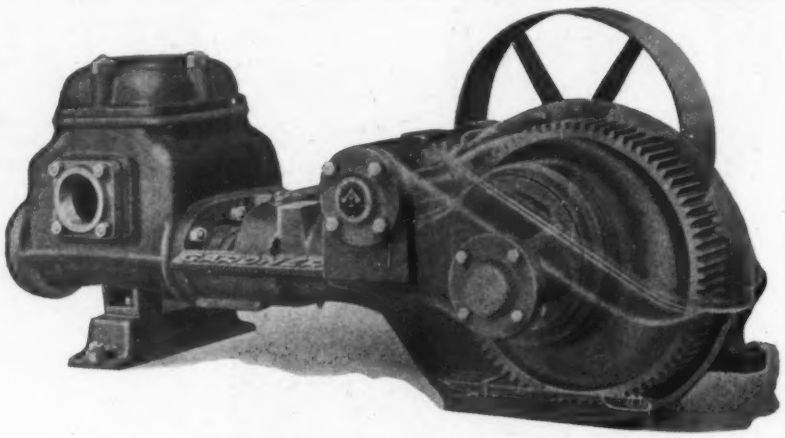
Automatic Synchronous Motor Control Perfected

The control of synchronous motors has always been considered a difficult and exacting operation, usually requiring special operators. The announcement that automatic synchronous motor controllers by which these motors are put under push-button control, have been perfected and are giving highly satisfactory service will no doubt be received with pleasure. The difficulty of starting the synchronous motor will no longer make it necessary to pass up the use of this very desirable motor in the many places where it should be used.

To complete the line of Electric Controllers and Manufacturing Company oil-immersed starting switches, the Type ZO Switch was developed. It is used for starting A. C. motors up to 10 HP across-the-line and can be used for remote control through push-buttons, float switches, pressure gauges, etc. This switch is enclosed and all of the contacts are under oil so that it is especially suited to use in places where fire hazards or corrosive atmospheres exist. It has the expansion wire overload device which gives 100 per cent protection to the motor against overloads and phase failures.

More detailed information will be supplied by the Electric Controller & Mfg. Company, 2700 E. 79th St., Cleveland, Ohio.

Automatic Synchronous Motor Control



Inside view of power end to show method of lubrication of Gardner self-lubricating power pump

Self Lubricating Pump Good for Refinery Use

The new enclosed type self lubricating Gardner power pump, manufactured by The Gardner Governor Company, Quincy, Illinois, is a general service pump for boiler feeding, water circulation, pressure boosting, water supply, or any other service where a pump is required. The enclosed construction and automatic lubrication should make these pumps popular in any installation. They are especially recommended for refinery use.

With an installation arranged so that the pump can be operated by a float switch or remote control, the pump can be started by merely turning a switch, and very little

---

value of the only variable T_2. Differentiating Y with respect to T_2 and equating to zero:

$$\frac{dY}{dT_2} = X\,W_{TC}\,T - \frac{M\,W_{TC}\,T}{K(1-J)} \times \left\{ \frac{J}{T_2(1-J) + JT_2 - t_1} - \frac{1}{(T_2 - t_2)} \right\} = 0$$

from which

$$-X\,K\,(1-J) = M\left\{ \frac{J}{(T_1(1-J) + JT_2 - t_1)} - \frac{1}{(T_2 - t_2)} \right\}$$

Expanding and simplifying,

$$XK = \frac{M\,(T_2 - t_2)}{JT^2_2 + ((T_2 - t_2 - J(T_1 + t_1))T_2 + t_2(T_1(J-1) + t_1} \quad (8)$$

Arranging in the form of a quadratic equation,

$$JT^2_2 + T_2 - t_2 - J(T_1 + t_1))T_2 + t_2(T_1(J-1) + t_1) - \frac{M(T_2 - t_2)}{XK} = 0 \quad (9)$$

from which,

$$T_2 = \frac{-(T_2 - t_2 - (T_1 + t_1))}{2\,J} + \frac{\left\{ (T_2 - t_2 - J(T_1 + t_1))^2 - 4J\left(t_2((J-1)T_1 + t_2 - \frac{M(T_2 - t_2)}{XK}\right) \right\}^{1/2}}{2\,J} \quad (10)$$

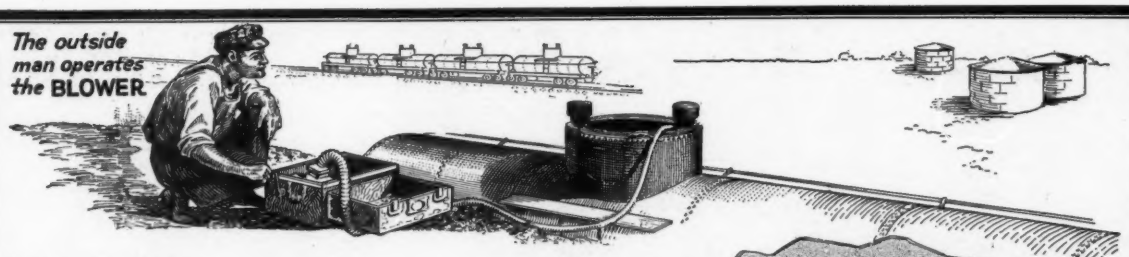
Assuming no heat loss due to radiation or other sources, the value t_2 is found from the relation,

$$t_2 = t_1 - JE(T_1 - t_1) \quad \ldots\ldots\ldots\ldots \quad (11)$$

The required heating surface (A) can now be computed from equation (4) by substituting the values just determined for T_2 and t_2. Strictly speaking, K depends upon T_2 and t_2, since the viscosity of the fluids varies as the temperature. However, the error introduced in (10) by substituting for K a value determined from approximate values of T_2 and t_2 is so small as to be negligible.

The value of the heat transferred is not always merely the value of the fuel saved. The natural gasoline plant, where the absorptive medium from the still must be cooled before it can be used again, offers a striking example of this. This is accomplished in two separate units, one a heat exchanger in which the medium from the still is cooled by the medium entering the still, and the other, a water cooler. What heat is not removed in the heat exchanger must be removed in the cooler, which involves additional expense for pumping and cooling equipment. This additional cost can properly be added to the value of the heat saved by the exchanger in computing the economic area of the heat transfer equipment.

The addition of heat exchangers to a plant may increase the capacity of the units in operation to such an extent that the building of new units which increased demand might otherwise require, will not be necessary. Proper allowance should be made in this case in computing the value of the heat saved. Heat exchangers, used in processes depending on high temperatures for large yields, may increase production valued in excess of the value of the fuel saved. Benefits so derived should be considered in computing the value of the heat saved in determining the economic area.



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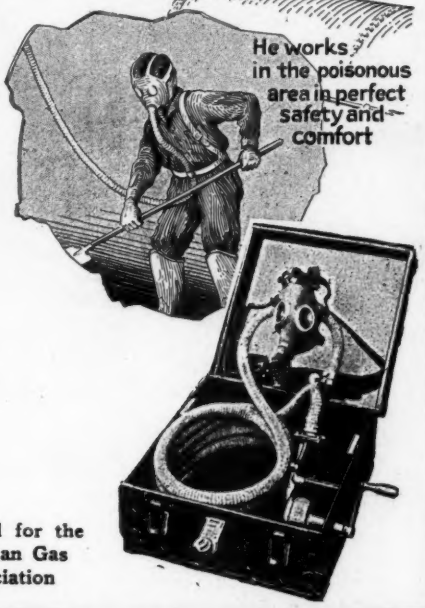
—and he'll work with greater ease, comfort and safety.

The M-S-A Standard
HOSE MASK

Supplies a continuous stream of fresh air to workers in Tank Cars, Oil Tanks, or in any confined gaseous space.

Send for Bulletin No. 99F for complete information on this and other types of Hose Masks

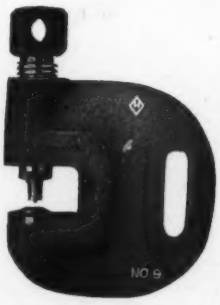
Mine Safety Appliances Co.
Braddock Ave. & Thomas Blvd. Pittsburgh, Pa.



Standard for the American Gas Association

HEAVY DUTY EXPANDERS FOR STILL TUBES

TOOLS FOR THE OIL INDUSTRIES



Hydraulic Pressure Pumps, 8000 pounds
Tube Expanders for Cracking Still Tubes
Hydraulic Pressure Pumps, 2000 pounds.
Tube Expanders for Condenser Tubes
Hydraulic Pressure Pumps, 500 pounds.
Tube Expanders for Steam Boilers
Screw Punches for Structural Shapes
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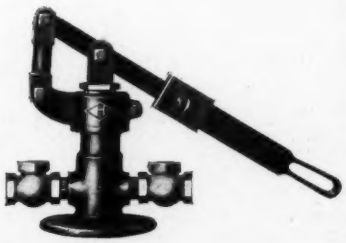
Screw Punches for Plate Work
Flaring Tools for Still Tubes
Beading Tools for Still Tubes
Hydraulic Jacks
Hydraulic Punches



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Wilmington, Del.

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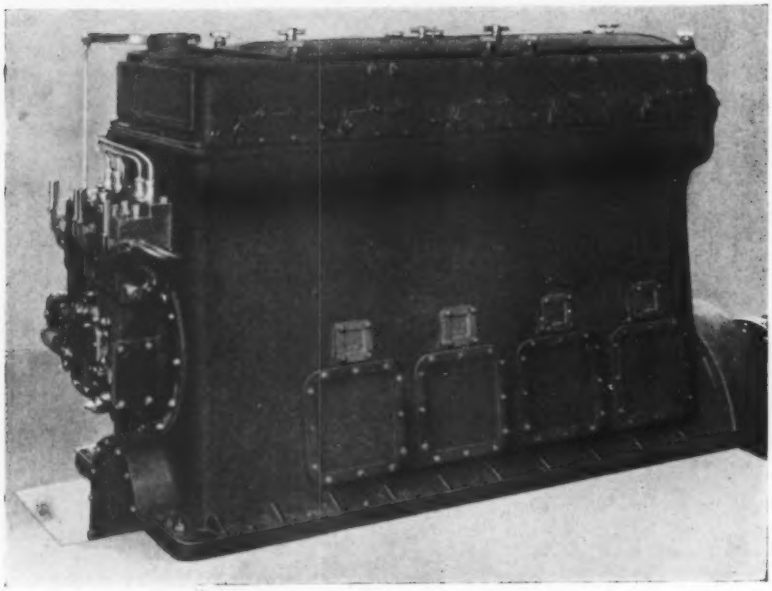


Diesel Engine for Foos Gas Engine Company

attention is required. In the centralized power plant the pump will undoubtedly find a big demand because of its reliability, automatic lubrication, and cleanliness.

All running parts in the pump are totally enclosed in the crank case which acts as an oil reservoir for the flood lubricating system, positive and automatic. The main driving gear partially submerged in oil delivers the oil through channels to the main and pinion shaft bearings, crank and cross head pin bearings and cross head guides. All working parts are literally flooded with oil which insures long life and continued smooth operation. Oil overflowing from the bearings is automatically returned to the crank case and can be used over and over again. A sediment pocket in the frame catches and retains any foreign matter.

The main gear is of semi-steel with a liberal pitch and face. Forged steel is used in the pinion. Teeth of both the gear and pinion are machine cut. Enclosed construction requires no gear guard except for top motor mounting.

Accuracy of detail is one of the main features of Gardner enclosed power pumps. Every part is built to gauge and is interchangeable.

On stock pumps, rubber or brass valves are furnished. Medium rubber valves are recommended for cold water service and hard rubber or brass valves for hot water. Brass valves in packed piston and outside packed pumps are light weight disc valves with curved web proportioned to give maximum strength with minimum weight. Oil line pumps have brass wing guided valves seating on a taper.

Complete information on this line of pumps can be obtained by writing the company, asking for Bulletin No. EP-1.

Graver Zeolite Water Softener Described

"Graver Zeolite Water Softener." This is the title of a new bulletin just published by the Graver Corporation, East Chicago, Indiana.

The bulletin is completely illustrated both with views of installations and of the softener and equipment.

The Graver Zeolite Softener uses the down flow method of softening with a natural zeolite mineral supported by a strainer plate. This strainer plate, which is attached to the shell of the softener, is perforated with equally spaced slots to provide thorough distribution necessity of a concrete fill in the bottom of the softener tank.

In writing to Graver Corporation for a copy ask for Bulletin 509.

Smaller Diesel Opens New Fields of Application

Reduction in physical proportions and weight has been accomplished in a new Diesel engine just perfected by the Foos Gas Engine Company, Springfield, Ohio, thereby opening new fields of application for this type of power.

This new engine has a speed approximately double that of other designs made by the Foos Company. Engine weight has also been reduced to about 50 pounds as against 100 to 300 pounds per horsepower. Capacity of the new engine ranges from 50 to 450 horsepower.

In many instances it will be possible to replace gasoline engines with the new Diesel, with a considerable reduction in fuel cost and maintenance as well. Direct drive to certain types of machinery is possible on account of the high speed range.

The engine is well suited for installation in mobile or semi-mobile industrial machinery requiring self-contained independent power units. In stationary applications it meets the requirements of a peak load or standby power generator.

Speed range of the engine is from 400 to 900 RPM, either with governor or mutual control.

More complete information will be mailed by the company on request.

Emergency Lighting Outfit for Power Houses

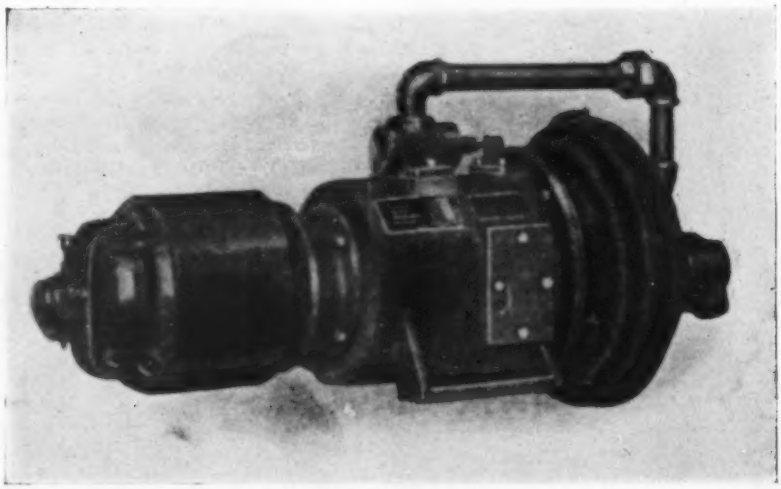
As an emergency lighting outfit in power houses and boiler rooms, the Standard Turbine Corporation, Scio, N. Y., is recommending its Standardlight Steam Generator Sets.

This generator set consists of a steam turbine and a direct current electric generator.

The set is generally furnished for 125 volts, and in capacities from 400 watt up to 10 K.W.

The set is furnished complete ready for connection to the electric light wires and requires no additional rheostats, storage batteris, or the like.

Due to the low weight and the compact design with consequent small space and ease and convenience in



Standard Light Steam Generator Set

C.S.C.CO.

TANK CARS

Builders of Quality Steel Tank Cars Since 1902

Specifications on Request

CHICAGO STEEL CAR COMPANY, Harvey, Ill. (Chicago Suburb)

"UNDER FIRE"

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The right refractory for your use

Without obligation, interested executives may obtain a helpful book free for the asking. 32 pages of useful, concise information

WALSH FIRE CLAY PRODUCTS COMPANY

NEW YORK · ST. LOUIS · CHICAGO

handling, this machine lends itself better than most machines as a portable unit.

The unit is entirely self-contained and needs no foundation.

The unit is designed for a minimum steam consumption at the capacity developed which is of considerable importance in many cases where the boiler capacity is limited.

While the unit as a whole is low in weight, all parts which especially require strength, such as shafts and bearings, are made heavier than competitive types, it being recognized that the service imposed on this type of machine in many cases is very severe and attention not always the best.

All moving turbine parts are completely enclosed.

The speed governor on the turbine will maintain the operating speed practically constant, regardless of load, and insures safe operation as well as constant voltage. The design of the machine is greatly simplified over any competitive makes, and the number of parts reduced to a minimum, which adds to the reliability of the machine and permits of operation over long periods of time without any other attention than periodical lubrication of the bearings.

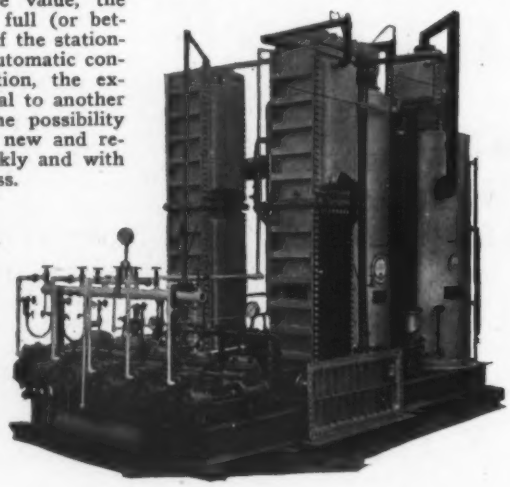
The sets are made for non-condensing service and will operate successfully under steam pressure as low as 50 pounds per square inch.

Further information may be secured from the company direct.

"SOUTHWESTERN"
portable absorption plants
make over
100,000 gallons of gasoline
daily

Only a little over a year on the market, the Southwestern Portable Gasoline Plant is operating successfully in the principal oil fields west of the Mississippi.

Today, over 100,000 gallons of gasoline are being produced daily by "Southwestern" Portable Gasoline Absorption Plants, with installations increasing at a most rapid pace. Operators appreciate the 100% salvage value, the "Southwestern" full (or better) efficiency of the stationary plant, the automatic control and operation, the expeditious removal to another location, and the possibility of getting into new and remote fields quickly and with minimum gas loss.



"Southwestern" Catalogs will be sent on request, covering refinery equipment and portable absorption plants.

SOUTHWESTERN ENGINEERING CORPORATION
1221 Hollingsworth Building, Los Angeles, California.

Factory: Culver City, Calif. Complete Refineries
837 Mayo Bldg., Tulsa, Okla. Collins Water Tube Boilers
Branch Factory: Tulsa, Okla. Power Plants

"The Hays Corporation" Is Company's New Name

Michigan City.—The Jos. W. Hays Corporation, Michigan City, Ind., manufacturers of Hays Draft Gages, Flue Gas Analyzers, CO_2 Recorders, and other combustion instruments, announces a slight change in name to "The Hays Corporation." Jos. W. Hays, who founded the business in 1907, has disposed of his entire holdings in the company in order that he may devote all of his time to his practice as consulting engineer. Philip T. Sprague, the new president, has been closely associated with this business for a number of years as vice-president and general manager.

Several new instruments have just been placed on the market by the Hays Corporation. These include a line of draft and pressure gages, and a portable test set for combustion investigations. The latter comprises a flue gas analyzer, flue gas thermometer, and portable aluminum draft gage, all arranged, with accessories, in a neat, compact carrying case.

Mr. Hays is widely known through his numerous books and through his many years practice as a consulting expert. He has recently associated with him a number of experienced combustion engineers and production specialists.

The headquarters of the consulting organization will be in Tulsa (Orpheum Building), where Mr. Hays has been located since last June. His associate engineers are located in Philadelphia, Niagara Falls, Pittsburgh, Chicago, Omaha, St. Paul, Parsons, Kan., Salt Lake City and Los Angeles. Through this country-wide organization Mr. Hays hopes to serve all industrial and power plants requiring his service.

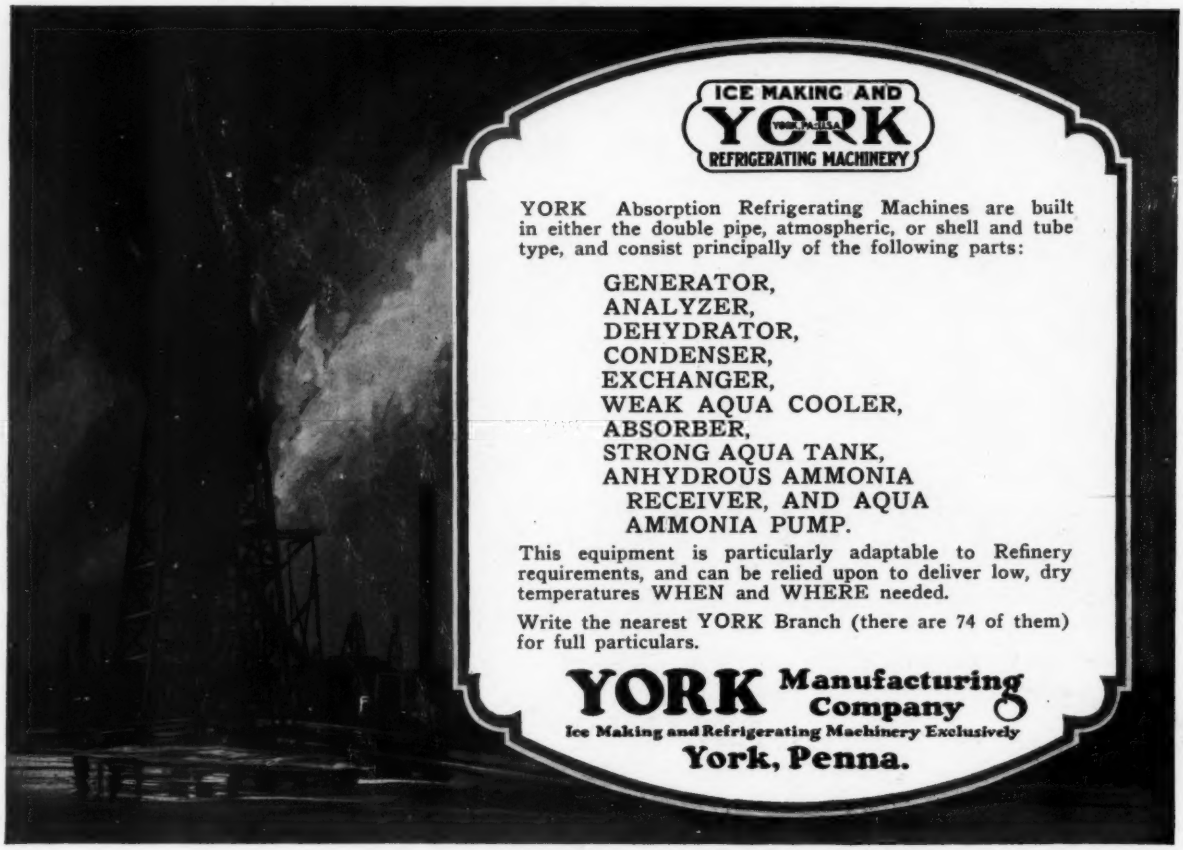
The headquarters of the Hays Corporation will remain in Michigan City, where the modern factory is being enlarged to take care of the expanding instrument business. Mr. Hays' well known book, "How to Build Up Furnace Efficiency," which is now in its seventeenth edition, 120th thousand, will also continued to be published at Michigan City.

New Celite Bulletins For Distribution

Celite Products Company, 1320 S. Hope Street, Los Angeles, Cal., announce for distribution two new bulletins on Celite products:

Sil-O-Cel C-3 and Sil-O-Cel C-3 Concrete discusses these two insulation products, and "The Logic of Insulation" is a brief discussion of the "how" and "why" of heat insulation and the advantages to be derived through its use.

Copies of both bulletins may be had upon request to the company.



ICE MAKING AND
YORK
REFRIGERATING MACHINERY

YORK Absorption Refrigerating Machines are built in either the double pipe, atmospheric, or shell and tube type, and consist principally of the following parts:

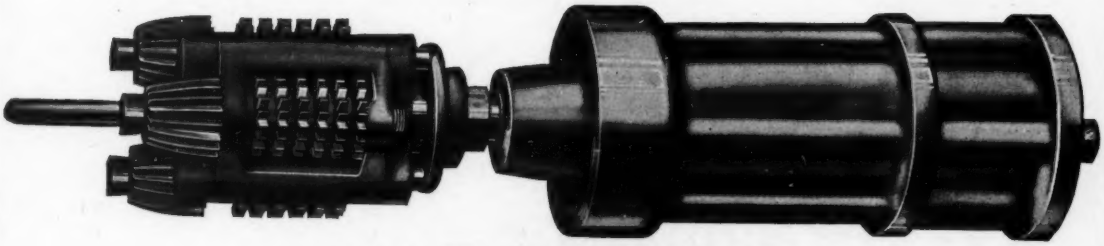
GENERATOR,
ANALYZER,
DEHYDRATOR,
CONDENSER,
EXCHANGER,
WEAK AQUA COOLER,
ABSORBER,
STRONG AQUA TANK,
ANHYDROUS AMMONIA RECEIVER, AND AQUA AMMONIA PUMP.

This equipment is particularly adaptable to Refinery requirements, and can be relied upon to deliver low, dry temperatures WHEN and WHERE needed.

Write the nearest YORK Branch (there are 74 of them) for full particulars.

YORK Manufacturing Company
Ice Making and Refrigerating Machinery Exclusively
York, Penna.

ROTO TUBE CLEANERS

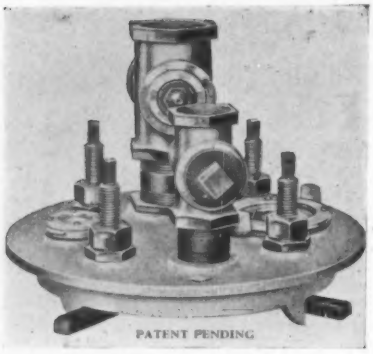


Roto Air-Driven Heavy Duty Cleaner

For

CRACKING STILLS

The Roto Company
HARTFORD, CONN.



Gastite Dome Cover Reduces Gasoline Evaporation

A patented gastite dome cover is now being manufactured and sold by the A. Y. McDonald Manufacturing Company, Dubuque, Iowa, and is recommended for loading casinghead, absorption, blending of straight run gasolines. It is claimed that this dome cover reduces evaporation and saves gasoline.

This cover is made in two styles. A "temporary type" for attaching to dome only during the loading process, is made of aluminum. A "permanent type" is offered in the heavier construction for permanent attachment to the dome and is furnished with a top which protects it in transit. Both styles are equipped with "peep hole glasses" so that the contents of the car can be inspected while loading. They are suitable for use on both insulated and non-insulated tank cars.

The cover is pierced by two valves which provide screw connections for the loading line and the vent line. The loading line opening is two inches in diameter, with a three-inch pipe attached to the under side of the cover and extends to within a few inches of the bottom of the car.

A vent line attached to the vent opening which is also two inches in diameter, carries all gases and vapors back to a compressor and cooling coil which converts them back to gasoline.

Further information about the dome cover will be supplied by the company on request.

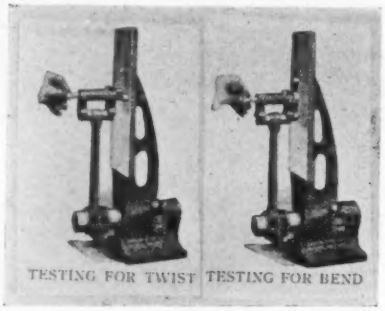
California Company Opens Branch Office In Tulsa

Tulsa, Okla.—B. F. Armstrong, sales engineer with the Southwestern Engineering Corp., of Los Angeles, has been transferred to the Mid-Continent office at Tulsa, Okla. He will assist R. B. Millard, district manager there, and will cover the Texas field for Southwestern.

Due to increased orders, crowding the factory, the Southwestern Engineering Corp. has opened a branch factory at Tulsa, Okla., where absorption plant equipment for the Mid-Continent territory will be fabricated, thus insuring better deliveries.

The Roxana Petroleum Corporation, operating in the Oklahoma and Texas oil fields, have recently ordered from from the Southwestern Engineering Corp. of Los Angeles, three portable gasoline absorption plants. On completion of the order the Roxana Company will have eight of these portable plants operating.

Amarillo Producers and Refiners Corporation have bought a gasoline absorption plant of a portable type, which is operating in a number of oil fields in the Mid-Continent territory. This plant was first introduced in California about a year ago. A plant of a similar type is to be installed at Tampico, Mexico, by the Anglo-Mexican Petroleum Co., Ltd.



Connecting Rod Aligner Is Handy Tool

Refinery machine shop foremen will find in the C-O Universal Connecting Rod Aligner, a valuable piece of equipment, and also a handy one. The aligner is used for testing the alignment of connecting rods and final piston assembly. By its use any connecting rod can be accurately tested as to alignment, and if the rod has been twisted or bent, it can be straightened readily by using either a large wrench or bending iron while on jig.

A bend and twist fixture is provided and alignment of rod is determined by using the fixture in conjunction with the piston pin to be used in final assembly. This fixture is provided with two points and to determine the exact alignment of rod, these points should be in contact with surface plate.

The aligner is furnished with one arbor or pin of desired size. Extra arbors can be furnished in any size desired from one and one-fourth to three inches in steps of one-sixteenth of an inch.

The aligning fixture is manufactured of cast iron, well seasoned, the surface plate being accurately ground. All arbors are hardened and ground. Net weight of the outfit is 20 pounds.

More information can be obtained by writing the Canedy-Otto Mfg. Co., Chicago Heights, Illinois.

Charcoal Plant

Cisco, Texas.—Humble Oil and Refining Company is erecting a small charcoal absorption plant of the portable type on Canary et al's J. P. Morris discovery oil and gas well in Coleman County, Texas. The plant will be equipped to handle several million cubic feet of gas daily, and in the event the field fulfills expectations, more units will be added.

PIONEER
TANK & BOILER Co.
TULSA-OKLA
Oil Refinery Tankage
CRUDE and STEAM STILLS
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CHANNELS, RIVETS
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SMITH COAL and COKE
Immediate Shipments from Tulsa Stock
PHONE O-1146 OR WRITE BOX 1926.

Let 'er Rain; Let 'er POUR—
It Can't Get Through the Moisture-Proof Case of AMERICAN RECORDING GAUGES

ENCLOSED in a moisture, fume and dust-proof case, the Recorder can be exposed to the elements without danger of injuring the movement.

Illustration shows an American (formerly Columbia) Recorder on a gas line in the Lucky Field, near Wetumka, Oklahoma. It gives an accurate, WRITTEN record of the pressure of the natural gas at all hours of the day or night.

Among the features which have made American Recorders the favorite in the oil industry are:

Time Punch, which gives a record of when and how often readings are taken. Non-removable Chart Holder, which prevents loss of button and makes it easy to change charts. Removable and adjustable Recorder Arm. Removable, non-corrosive, non-spilling Glass Pen. Extra heavy and non-corrosive movement.

American Recorders are the product of gauge makers who have back of them over three-quarters of a century of experience.

Write for Catalog E-16

AMERICAN SCHAEFFER & BUDENBERG CORP.
BROOKLYN, N. Y.

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**Stock Carried at these branches.*

Controlling Liquid Levels

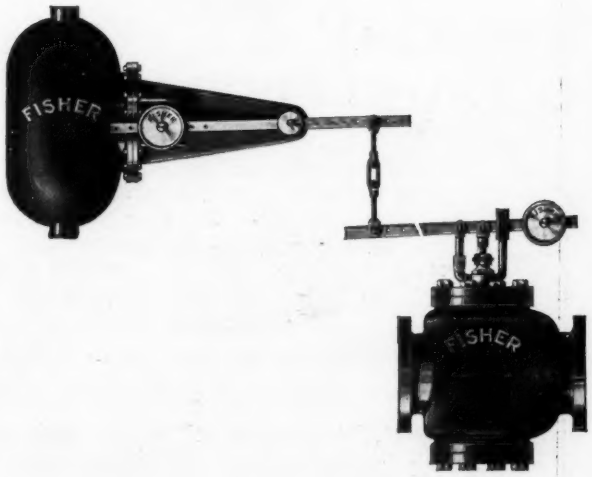
FISHER
TRADE MARK REGISTERED

Holding a pre-determined level of liquid in stills, absorber towers, receivers, pipe lines, is an easy problem with Fisher Type No. 227A.

On any job where it is impractical to place the float inside the vessel holding the liquid, this type will prove its value immediately it is put on the work.

Simple in construction, accurate in design, positive in action, it is a piece of equipment that has won a host of enthusiastic friends in the oil industry.

Ask us for our new complete bulletin, now ready.



THE FISHER GOVERNOR CO.

MARSHALLTOWN, IOWA

Mention Where You Saw the Advertisement

Knox Process Fuel Submitted to Bureau Of Standards

THE advent of a new motor fuel which will, according to its sponsors, lessen operating costs for the public by increasing mileage, do away with carbon troubles, eliminate "knocking" in cylinders, and above all, help to conserve the country's supply of crude oil, was announced in Washington Monday, June 28, when Charles P. Tolman, chairman of the research committee of the Petroleum Conversion Corporation of New York, submitted a report with samples of the new fuel to the Bureau of Standards for analysis and test.

Request was made that the government bureau make a thorough examination of the data and material filed, and at the same time Mr. Tolman, who is a widely known consulting engineer, expressed the hope that the bureau might see fit to suggest an appropriate classification for the fuel since it is in no sense gasoline.

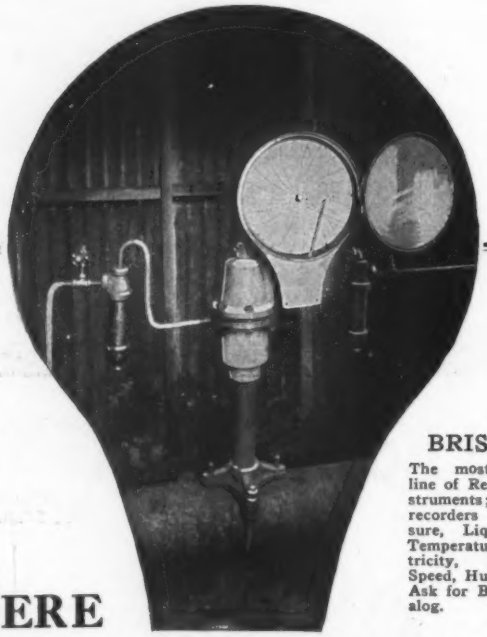
"This presentation to the Bureau of Standards," Mr. Tolman stated, "is the culmination of five years consistent experimentation and development. We are sure of our ground when we inform the government we have found a new and better motor fuel, and we wish to avail ourselves of the facilities of the bureau which are unequaled in this country, not only to confirm the findings of our own laboratory, but to establish the exact nature of certain components which may have a wide use outside the petroleum industry. In the course of this work a plant of size and capacity not only for proving up the theory, but equally to prove the controllability of the process when carried on in apparatus of commercial size, was built and operated by us at Texas City. Now that we have satisfied ourselves of the merit and usefulness of this motor fuel, we are going to demonstrate and introduce it."

The reason assigned by Mr. Tolman for desiring classification other than gasoline for the new product, is explained by him this way: "The new motor fuel is made up of compounds more stable than gasoline, weighs more per gallon, and is chemically different. It would seem, therefore, that the product should be recognized as something other than gasoline."

Explaining just what is now claimed to have been discovered, and its possible usefulness to the public, Mr. Tolman said: "For the first time, the aromatic compounds, meaning benzene and toluene, are made not as a by-product but as a main product on an industrial basis under the new discovery. We are prepared to deliver bulk samples of the new motor fuel to the government, in addition to the samples filed with the Bureau of Standards. We believe the official testing will be actively undertaken because this product is in line with the government's policy of conservation and interest in advancing aviation for military and mail purposes.

"Our problem and our job was to build a plant that would apply large quantities of heat to large quantities of oil under absolute control as to temperature, pressure and atmosphere, and also to control each of these factors simultaneously and independently of each other. Such a result has finally been attained and it means much to the petroleum industry. Summed up, it means we have devised and established a method whereby all fundamental conditions governing the conversion of oil are subject to simple, exact and definite control.

"Existant methods, it must be remembered, apply heat to the oil externally through metal walls. Temperatures higher than those necessary for reaction must be used to cause the heat to penetrate the mass, whereupon the oil is not uniformly heated. We, upon the other hand, apply our heat internally, by commingling heated gas in the system with oil vapors at controlled pressure, so that the oil is at once heated to conversion temperature. Thus the heat is applied uniformly to



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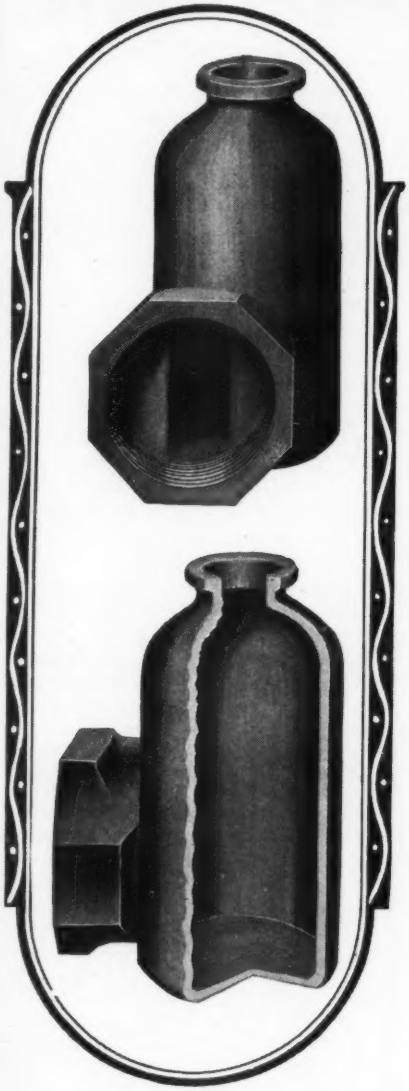

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Marley Spray Pond Installations are designed from the standpoint of great economy with low operating pressure by engineers with years of experience in spray pond design. The results that have been obtained are such as to prove conclusively the great efficiency and dependability of Marley installations.

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every particle of the oil at definite temperature and pressure.

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The Petroleum Conversion Corporation, operating the Knox Process, has offices at 136 Liberty Street, New York City, and its Research Department has invited press representatives to obtain there any further detailed information desired. The personnel of the board which has guided the affairs of the enterprise, includes many persons well known as engineers and business men in New York, Philadelphia and elsewhere.

"Automatic Pumping" Is Bulletin Title

"Automatic Pumping," is the title of a new twenty-four page booklet issued by Barrett, Haentjens & Co., Hazleton, Pa.

Other bulletins have been issued by this company describing the automatic operation of centrifugal pumps, but the latest edition differs from the others in that the subject is treated from a purely technical standpoint and several new methods of making centrifugal pumps automatic are described.

Copies of this booklet can be secured by writing Barrett, Haentjens & Co., and asking for bulletin 400a.

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Phillips Building Largest Natural Gasoline Plant In Panhandle Field

Breckenridge, Texas.—Three natural gasoline manufacturing plants are being erected in Texas fields by the Phillips Petroleum Company, which maintains headquarters here for all of Texas field operations. Included in this trio of new plants is one for Hutchinson County, in the Texas Panhandle, that will probably handle a greater volume of gas than any single plant in the world, while two small types of charcoal process plants are being erected in Stephens and Brown Counties.

The Panhandle district plant is located on the Johnson ranch, Mary Whitley survey, near the heart of the Hutchinson County field, and has been under construction for several months. This plant is being built to handle a maximum of 100,000,000 cubic feet of gas daily, operating on well pressure, with a comparatively lean gasoline yield. The first unit of this plant has been completed and put on production, and the finished product is moved by a 3-inch welded pipe line to loading rack at Panhandle, a distance of about 26 miles.

In conjunction with this large plant, Phillips is erecting a charcoal process plant on the J. K. Hughes Development Company's lease in the northwest quarter of section 6, block "Y," and plans to erect a second charcoal plant on the Dixon Creek Oil Company's Smith lease. The output of these charcoal plants will be pumped to the main gasoline plant, where the product will be stabilized. The residue gas from these plants will be boosted over to the Western Carbon Company's carbon black plant, located on the Carson-Hutchinson County line. The carbon black plant is completing its first unit, and when completed will burn 20,000,000 cubic feet of residue daily, while application has been made with the Railroad Commission to greatly increase the capacity.

Phillips Petroleum Company is erecting a charcoal absorption plant on the Hohertz lease, section 63, T. P. Railroad survey, block 4, Stephens County, and will be ready for operations in August. This plant will be of the two unit type, with a daily capacity of 2,000,000 cubic feet of gas. A charcoal plant is being constructed on the M. J. Suttles farm, Robert Mitchell survey, to take gas from shallow wells being developed in the southeast extension of the Cross Cut field, Brown County. This plant will be equipped to handle about 3,000,000 cubic feet of gas daily. The gasoline yield in both of these plants will average two and one-half gallons per 1000 cubic feet.

EXTRACTS OF REFINING TECHNOLOGY

Action of Sulphuric Acid on Gasoline.—Two varieties of gasoline were treated with sulphuric acid in a series of washes. The strength of the acid was increased steadily at each wash, from 79.1 per cent to 100.5 per cent. Determinations of percentage loss of weight, density, refractive index, and aniline point, following this treatment indicated that polymerization and removal of unsaturated compounds take place with acid of strength below 88 per cent, and that with acid of greater concentration removal of aromatic compounds takes place. Journal of the Institute of Petroleum Technologists, 1926, volume 12, pages 68-76.

* * *

Regenerating Spent Decolorizing Powders.—A new method for the regeneration of spent decolorizing powders that are employed in the mineral oil industry is described in Kolloid Zeitung, 1926, volume 28, pages 247-248. The feature of the method is that the decolorizing powder need not be removed from the filter to effect its purification. The method consists of mixing the spent material with benzene and alcohol and extracting the impurities from it by means of this mixed solvent. The heating that afterwards ensues is carried out at a temperature of 150 degrees C.

The extraction power of a solvent depends on its heat of wetting. Alcohol has a comparatively high heat of wetting, that is 17.2 calories per gram against "Floridin S". But it is not a good solvent for the impurities that it is desired to extract. On the other hand benzene is a bad "wetter" but a good solvent. The combination of the two thus effects satisfactory extraction. By the application of this method the same sample of Floridin was used for about 30 operations without any marked diminution of its decolorizing power.

* * *

Machine Lubricating Oils.—An interesting article on the lubricatings that are used for the lubrication of machinery is published in Petroleum Zeitschrift, 1926, volume 22, pages 247-53.

It is stated therein that the most important qualities of a lubricant are its oiliness, or property of clinging to the lubricated surface, and its viscosity or internal friction. The greater the viscosity of the lubricating oil, the less the expenditure of lubricant, and the less it is liable to be displaced from between the bearing surfaces, but the greater is the friction. The oil should have minimum viscosity consistent with sufficient oiliness to ensure adherence to the rubbing surfaces.

For greater speeds of rubbing surfaces oils of lower viscosities are required. The oil must resist change from the action of the air and high temperatures, must have a reasonably high flash point, must be quite free from inorganic acidity, and not have excessive organic acidity. Its boiling point should be high and its cold test low. The properties of various vegetable and animal oils, which possess greater oiliness than mineral oils, are discussed as to their suitability for use in compounding mineral oils, and the requirements in lubricating oil for engines and machines of different categories are also discussed.

* * *

Composite Motor Fuel.—British Patent No. 249,348 describes a composite motor fuel which consists of gasoline or other usual hydrocarbon fuel, a soluble aldehyde and an unsaturated hydrocarbon gas which will remain in solution at atmospheric temperature. Thus acetaldehyde or paraldehyde is saturated at atmospheric temperature and pressure with acetylene and from two to twenty liters of the solution are mixed with 98 to 80 liters of gasoline.

* * *

Refined Liquid Hydrocarbons.—Mineral oils are refined by distilling

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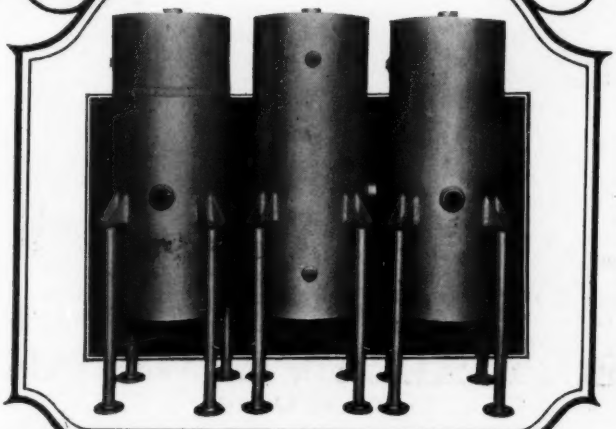

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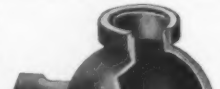

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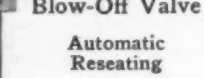

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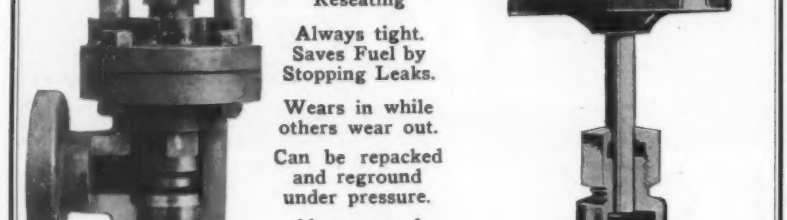

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with non-superheated steam in the presence of alkali hydroxide or alkaline earth hydroxide. The products may be subsequently treated at an elevated temperature with hydrogen, or gases containing free hydrogen, in the presence of a finely divided metal, preceded or not by treatment with fuller's earth or other absorbent. Nickel, copper, iron, cobalt, platinum or alloys of these metals, with or without promoters or activators are indicated as suitable metals.

Hydrogenation may or may not take place. The treatment with hydrogen may be carried out at atmospheric, reduced or increased pressure.

In an example 100 pounds of tar obtained by the low temperature carbonization of coal, lignite, or other carbonaceous matter is mixed with one pound of sodium hydroxide or slaked lime and distilled with steam. The distillate is passed into a tower maintained at a temperature of 100 to 110 degrees C and packed with pumice stone coated with reduced nickel carbonate or nickel aluminate silicate, hydrogen being passed in parallel or in countercurrent. Or the steam-distilled oil is agitated at a temperature of 100 to 110 degrees C in the presence of finely divided metal while hydrogen is passed through. It has also been proposed to distill the hydrocarbon in the presence of alkali hydroxide, or alkalin earth hydroxide with the aid of steam, and to distill it as well with ordinary steam in the presence of alkali and in particular a solution of commercial soda. British Patent No. 249,309.

Chemistry of Sweetening of Benzine Distillates.—"Sweetened" benzine is attained according to the equations:

$RHS + NaOH = R.S.Na + H_2O$. and $2RSNa + S = R_2S_2 + Na_2S$. The mercaptans are thus converted into the corresponding disulphides. The reaction: $Na_2S\ 2H_2O + Na_2PbO_2 = PbS + 4NaOH$ also takes place. A similar reaction takes place between mercuric oxide and mercaptans: $2RHS + HgO = Hg(RS)_2 + H_2O$; $(RS)_2 Hg + S = HgS + R_2S_2$.

The reaction between a mercaptan and sodium hydroxide in the presence of sulphur was verified by dissolving normal butyl mercaptan in a solution of sodium hydroxide and shaking with sulphur. An oil separated which boiled at a temperature of 220 degrees C., corresponding with normal butyl disulphide. Lead sulphide and lead mercaptides may be separated with the aid of glacial acetic acid with increasing percentage content of the higher mercaptans, the quantity of mercaptide in the precipitate decreases. With normal butyl mercaptan, the precipitate contained 46.3 per cent of lead sulphide. With octyl mercaptan it was 84 per cent and with cetyl mercaptan the lead sulphide content was 100 per cent. Cracked distillates from crude oil gave a precipitate containing 17 per cent mercaptide. Pressure distillates from

Mexican crudes gave a precipitate which contained 15.4 per cent. By heating to a temperature of 110 degrees C and then keeping a long time or freezing, lead mercaptides were separated from the cracked distillates or from the pure compounds dissolved in petroleum ether. It was thus found that the solutions of lead mercaptides in oil have different stabilities. Mercaptides of the higher molecular weight were found to be most soluble in oil. Petroleum Zeitschrift, 1926, pages 218-19.

* * *

Refining of Cracked Distillates.—The use of sulphuric acid, alkali, lead oxide and water is sufficient in the refining of cracked distillates. The use of sulphur may usually be omitted and is necessary in special cases only. The alkali has the effect of removing the hydrogen sulphide, and the lower members of the mercaptan series if they are present. Solutions of plumbite have the same effect and when this purifying agent is employed, lead mercaptides are formed. Some of these mercaptides remain in solution while others are precipitated.

During the distillation process further precipitation takes place in accordance with the reaction: $Pb(RS)_2 = R_2S = PbS$. Inasmuch as the alkyl sulphide does not react with "doctor" solution, the benzine is "sweet." A previous treatment with plumbite solution gives lead sulphide and lead mercaptides which react with sulphuric acid in the following manner:

$(RS)_2Pb + H_2SO_4 = 2R.SH + PbSO_4$; $2RSH + H_2SO_4 = 2H_2O + SO_2 + R_2S_2$.

Or when the two reactions are combined we have the following equation:

$(RS)_2Pb + 2H_2SO_4 = R_2S_2 + 2H_2O + SO_2 + PbSO_4$.

For further details see Petroleum Zeitschrift, 1926, page 219.

Simms Ready

Dallas, Texas.—The Simms Oil Company will start construction work in July on a skimming and cracking plant to be located in the Smackover field, Arkansas. Two Cross cracking units have been ordered for the plant, with a combined cracking capacity of 2000 barrels daily, while one unit of pipe still of 3000 barrels daily capacity will be installed. The location of the plant affords excellent shipping facilities, while only a short pipe line haul will be required on all the crude put through the plant, which is scheduled for completion by January 1, 1927. E. J. Mary will have charge of operations, while Frank Gardner is the construction engineer.

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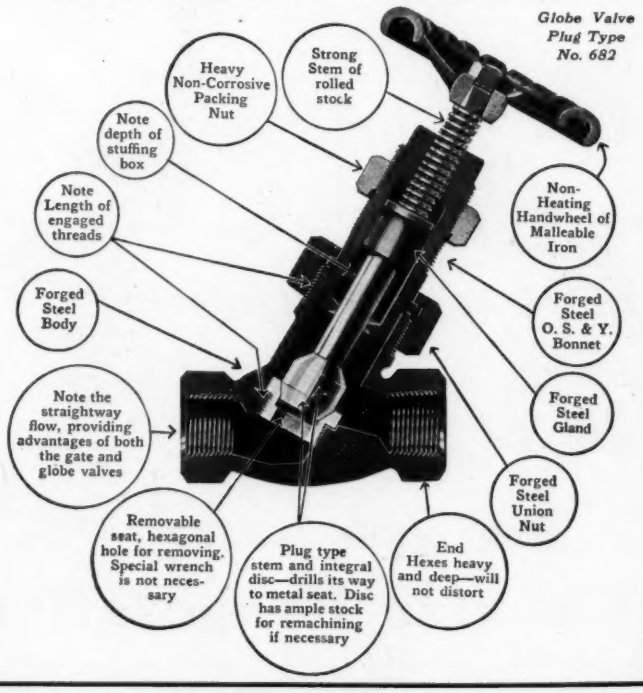
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Roeser - Pendleton, Inc., Start Gasoline Plant

Fort Worth, Texas.—Roeser-Pendleton, Inc., with headquarters at Fort Worth, will re-enter the natural gasoline manufacturing business by the construction of an absorption plant in the Cook Ranch shallow high gravity field in Shackelford County, Texas. This concern disposed of two large plants in Stephens County to the Phillips Petroleum Company several years ago.

The Cook Ranch plant will be equipped to handle about 3,000,000 cubic feet of gas daily, with a gasoline yield of about four gallons per 1000 cubic feet. The plant will be a five unit installation, using the Newton Process stills and absorbers, and 80 h.p. Clark engines. Marshall R. Young is general superintendent and G. P. Crutchfield has charge of the construction work.

Bristol Instrument Catalog Out

Bristol tachometers for recording and indicating are fully illustrated and described in a catalog published a short time ago by the Bristol Company, Waterbury, Conn. This is a 25 page catalog and gives complete information on all Bristol products. Copies may be had by writing the company and asking for catalog No. 1700.

Portables For Panhandle

Dallas, Texas.—Two portable crude refineries, having a combined daily capacity of 5000 barrels, will be moved to the Hutchinson County field in the Texas Panhandle, according to T. W. Sowell, president of the Portable Refining Company, with headquarters in the Magnolia Building here. The plants are to be set up on a switch track of the oil field spur line now being built by the Santa Fe Railroad from the town of Panhandle to Isom, located in the heart of the field. One plant is awaiting shipment from the East Chicago factory of the Graver Corporation, while a smaller one is at Wortham, where it operated for a few months during the flush period of the Wortham field.

A 40-foot Wiggins Roof on an all-welded rundown tank at a refinery.

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WIGGINS ROOF

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Painting Tank Cars Inside

(Continued from page 30)

half is required with a paint brush in applying a coat of paint to the inside of a car, whereas thirty minutes only are necessary with a paint gun operating with compressed air. Four hours are allowed for the first coat to dry with the outlet caps and dome covers left off for the free circulation of air which aids in drying. In applying the second coat which is applied straight a little more time is required and eight hours are allowed for drying before loading the car.

Lead poisoning among tank car painters is very rare but there have been instances where the painter has become ill from staying too long in the shell of a car while painting. The body will absorb a slight amount of any substance through the pores of the skin and this is very likely inside of a car. Where the men are working in relief there is practically no likelihood of the men suffering any ill effect. After the painting and drying has been completed with other necessary repairs the car is ready for loading and is then placed in position for loading at the loading rack. The loading of gasoline and blending of the various products is another interesting process.

The loader is given the product to be loaded and the proper outage is figured from a chart. It is known that heat expands and cold contracts with liquids as with other substances and this must be taken into consideration for the protection of those concerned. At 60 degrees F. the product is loaded shell full and if the product is below 60 degrees F. the outage is figured according to contraction and if above 60 degrees F. the expansion is allowed.

After the car has been loaded and a sample of the contents taken for the laboratory tests the car is tagged with an inflammable placard and sealed. Before the car is allowed to leave the refinery's yard the tests have been made on the loaded product and if the contents are up to specifications the car is billed out to its destination.

REFINERY AND GASOLINE PLANT ACTIVITIES

Skelly in Panhandle

Amarillo, Texas.—The Skelly Oil Company is in the midst of a big expansion program on natural gasoline plant operations, and is building a standard type of absorption plant, with five portable charcoal plants to be operated in conjunction with the main plant. These plants are all located in the Hutchinson County section of the Texas Panhandle district, and represent an expenditure of approximately $1,250,000. Emby Kaye is supervising the construction work on these plants.

The main plant is located in section 4, D. & S. E. Ry. survey, block B-4, and will handle 12,000,000 cubic feet of gas daily when all the units are installed. The charcoal plants are to handle about 6,000,000 cubic feet of gas daily each, and the manufactured product will be piped to the main plant for stabilization. Two plants will be located in section 5, M. & C. survey, block "Y," and one each in sections 6, 11 and 20, M. & C. block "Y." The materials for these plants are transported by trucks from the nearest railroad point at Panhandle to the locations, a distance of about 30 miles. Since the Santa Fe Railroad is building a spur line from Panhandle to the heart of the Hutchinson County field, Skelly has arranged to store the gasoline production in 10x40 size Graver special pressure tanks until direct rail deliveries can be made to market. About 40 of these tanks have been ordered to date by Skelly.

Skelly has made application with the Railroad Commission for a permit to make carbon black from the residue gas from its Hutchinson County plants, and if the permit is authorized the Godfrey L. Cabot, Inc., Boston, Mass., will erect a 25,000,000 cubic foot capacity plant.

Charcoal Plant For Texas Company

Tulsa, Okla.—A second portable charcoal plant for the Texas Company in the Davenport field is now being installed. The Gasoline Recovery Corporation is furnishing the plant.

Offices of the Filtrol Company, of Los Angeles, California, have been moved from 215 A. G. Bartlett Building to 506 A. G. Bartlett Building.

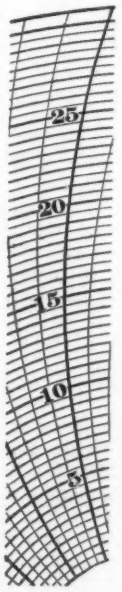
N. P. A. to Meet Sept. 15-17 in Atlantic City

Washington, D. C.—The fall semi-annual meeting of the National Petroleum Association will be held September 15, 16 and 17, at the Traymore Hotel, Atlantic City. Last September this organization held its meeting in Atlantic City.

The program is to be worked out during the next few weeks. This will include both economic and technical subjects, as well as some concerning the welfare of the organization.

Ismar Ginsberg, consulting chemical engineer announced on May 1 the removal of his offices to 1430 Aeolian Bldg., 33 West 42 Street, New York City.

Henry Eggelhof of Dallas, Texas, has recently been appointed exclusive representative for the eastern section of Texas by the Uehling Instrument Company of Paterson, New Jersey.



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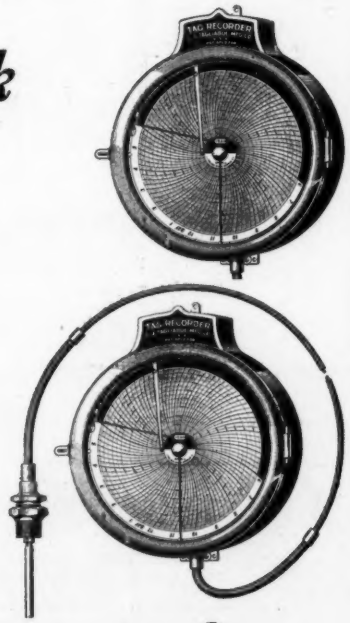

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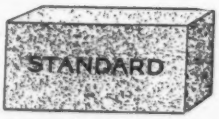

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Recent Refinery Patents

Washington, D. C.—The following patents of interest to refiners have been granted by the United States Patent Office:

No. 1,582,893, granted May 4 to Otto Behimer, Port Arthur, Texas, assignor to The Texas Company, New York, for an apparatus for treating hydrocarbon oil, consisting of a vessel provided with internal heating means and a hinges jacket formed of heat insulating material.

No. 1,582 899, granted May 4 to Perry Cassidy, Riverside, Conn., assignor to the Babcock & Wilcox Company, Bayonne, N. J., for an apparatus for treating oils comprising a container for the oil, heads spaced apart and dividing the container into compartments, tubes extending through the space between the heads and connecting the compartments at either end thereof, nozzles placed near the ends of some of said tubes so as to induce a flow of oil through the tubes when steam or a gas is injected through the nozzles, and means for supplying steam or gas to said nozzles.

No. 1,582,923, granted May 4 to Harry F. Glair and Oscar E. Bransky, Whiting, Ind., assignors to Standard Oil Company, Whiting, Ind., for a method of separating wax from lighter wax-bearing, substantially uncracked oil distillates which consists in admixing therewith a hydrocarbon oil of lower viscosity and heavier than burning oil, chilling and filter-pressing the mixture.

No. 1,582,929, granted May 4 to Robert E. Humphreys, Whiting, Ind., assignor to Standard Oil Company, Whiting, Ind., for a still, including a heating chamber having a furnace connected thereto, an upper and lower drum located outside said heating chamber and furnace, tubes connecting the drum and passing through the heating chamber, storage drums above and outside said heating chamber, and connections between said storage drums and said upper and lower drum, located outside said chamber.

No. 1,583,340, granted May 4 to Robert Henry Crozier, London, England, for apparatus for the fractionation of hydrocarbon oils and like liquids including columns through which the vapors to be treated may pass serially upwards, pipes containing heating medium and traversing said columns, columns alternating with said first-mentioned columns through which the vapors may pass serially downwards, pipes containing cooling medium and traversing said second-mentioned columns, a connection between each column of the first series and a column of the second series, means connecting the pipes containing cooling medium serially and means connecting the pipes containing

heating medium serially and condensate collecting boxes disposed beneath and open to the lower ends of at least some of said columns.

No. 1,583,600, granted May 4 to John White McBurney, Youngstown, Ohio, for a device for testing oil, comprising thermo-couples so placed that they will be affected by the difference in temperature within a body of oil and at a point just above the surface of the oil, and temperature indicating means.

No. 1,583,692, granted May 4 to Alexander Ivanovitch Kousnetzoff, London, England, for a vaporizer comprising a hollow walled chamber, gas inlet and outlet ports in the chamber, a hollow conical spreader within the chamber with its apex directed toward and concentric with the inlet, the chamber being formed to leave an annular space between inner wall and the outer wall of the spreader and means for heating the inner wall of the chamber and the outer wall of the spreader, partitions dividing the annular space into a pulrality of separate divergent channels, and means at the exit ends of the channel to impart a whirling motion to the material flowing through the channels.

No. 1,583,746, granted May 4 to Daniel Pyzel, Piedmont, Cal., assignor to Simplex Refining Company, San Francisco, for an oil refining system consisting of a still; a tight shell; means for delivering the cold oil to be refined to the top of said shell; means inside said shell for finely dividing and spreading the oil as it passes through said shell; means for passing the vapors from said still upward through said shell in intimate contact with the oil passing downwardly through said shell so that it may condense and absorb a portion of said oil and its associated condensates from said shell and delivering it to said cooler; means for delivering said cooled oil and condensates into the top of said shell; and means for delivering oil and its associated condensates from the bottom of said shell to said still.

No. 1,583,973, granted May 11 to Ralph C. Holmes, New York, and Frederick T. Manley, Houston, Texas, assignors to The Texas Company, New York, for an apparatus for cracking oils including a plurality of vertically disposed retorts, overflow pipes connecting said retorts in series, pipe connections between the vapor spaces of said retorts, means for heating said retorts below said overflow pipes adapted to impart most heat to the first retort of the series, means for supplying oil under pressure to the first retort of the series and causing it to pass progressively through the other retorts, means for drawing off the vapors as they are evolved from the retorts, means for separating out the unconverted portions of said vapors and returning them to the bottom of first retort for treatment, and means for condensing the remaining vapors under pressure.

No. 1,584,048, granted May 11 to Alexander Thomas Stuart and Guy Noverre

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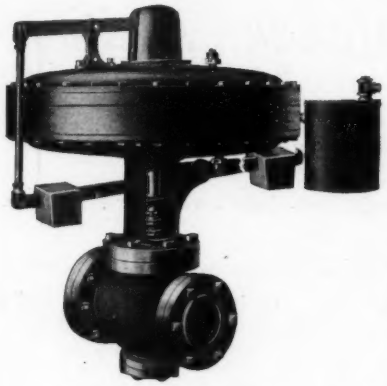

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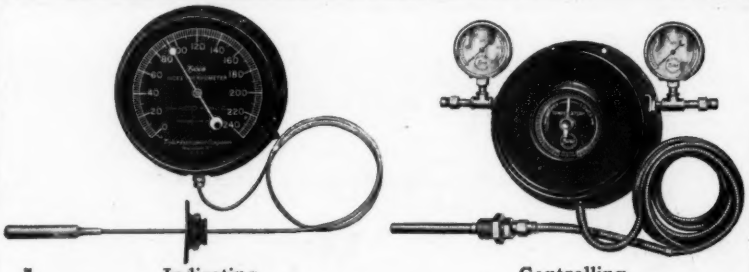

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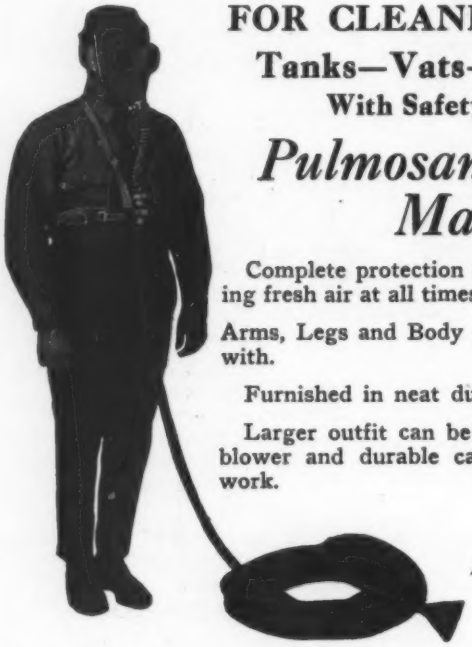

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Middleton, Toronto, Ontario, Can., assignors, by mesne assignments to Farley G. Clark, for an apparatus for heating treatment of hydrocarbons comprising a cracking retort of heavy walled metal pipe encased in heat insulation and having sufficiently low electrical conductivity to act as a resistor, means for passing current through said pipe to heat the retort to a relatively high temperature, said retort being provided with a feed intake and a vapor offtake, adjustable means for feeding to said intake a mixture of a hydrocarbon and a gas, condenser means connected to said offtake, and a return trap device connecting said condenser means with said intake.

No. 1,584,504, granted May 11 to Harold B. Bernard, Tulsa, Okla., assignor to Sinclair Oil & Gas Company, Tulsa, for an apparatus for separating absorbed constituents from liquid absorbents comprising an exhausting tower, means for promoting gas and liquid contact and heat exchange in the tower arranged above the bottom thereof, a partition arranged in the lower part of the tower, dividing it into a heated supply compartment and a discharge compartment opening upwardly into the tower, means for introducing charged liquiding absorbent into the supply compartment and discharging the withdrawn liquid into the tower over the upper part of the contact promoting means, means for conducting liquid from the lower part of the contact promoting means to the discharge compartment, and connections for withdrawing vapors and gases from the upper end of the tower and for withdrawing liquid from the discharge compartment.

No. 1,584,588, granted May 11 to Edward Goodrich Acheson, New York, for a process of treating mineral lubricating oils to enhance their lubricating value, comprising agitating the oil with a selective solvent for the components of lower lubricating value, settling the mixture and separating the treated oil, and recovering the solvent from the solution for re-use in the process.

No. 1,584,730, granted May 18 to William Edgar Chenot, Belleville, Ill., for an improved method of distilling hydrocarbon oils, which comprises initially distilling the original oil, dephlegmating the vapors, re-distilling the condensate obtained by this dephlegmation by heat interchange with the original oil undergoing distillation but without direct contact therewith, and collecting in a common receiver the uncondensed vapors from the dephlegmation and the vapors of the re-distilled condensate obtained from the redistillation without contacting them with the oil being distilled, the same condensate, or the vapors undergoing dephlegmation.

No. 1,585,224, granted May 18 to Clive Morris Alexander, New York, for a process of non-destructive distillation, comprising passing the oil in one direction through a zone where it is heated, injecting steam into the oil at a plurality of points along its passage through

said zone and causing same to flow therethrough concurrently with the oil, maintaining the liquid and vapor phases present in intimate contact up to the point of separation, so as to raise the mean vapor tension, and separating the lighter and heavier fractions by fractional condensation.

No. 1,585,233, granted May 18 to John W. Coast, Jr., Tulsa, Okla., assignor by mesne assignments to Doherty Research Company, New York, for a method of treating hydrocarbon oils which consists in subjecting a body of oil to the simultaneous action of heat and pressure and distilling off the lighter fractions and simultaneously cracking the intermediate boiling point products, withdrawing a portion of the oil body under pressure, releasing the pressure on the said portion to withdraw the intermediate boiling point products therefrom and passing the said products into contact with the supply of oil delivered to the oil body under treatment in order to heat the said supply of oil and to distill the lighter hydrocarbons therefrom.

No. 1,585,263, granted May 18 to George L. Prichard and Herbert Henderson, Port Arthur, Texas, assignors to Gulf Refining Company, Pittsburgh, for a process of crystallizing oils with aluminum chlorid, which comprises transmitting a mixture of such an oil with aluminum chlorid once through a heating zone, at a temperature sufficient to cause chemical reaction to occur and allowing the mixture to freely expand in a releasing chamber with extrication of vapors of volatile oils formed by such reaction.

No. 1,585,355, granted May 18 to Joseph H. Adams, Brooklyn, N. Y., assignor to The Texas Company, New York, for a continuous method of converting high boiling hydrocarbon oil into lower boiling products that comprises continuously heating a moving stream of oil under superatmospheric pressure to a point of incipient vaporization while maintaining it in liquid form, delivering the heated oil to and forcing it under superatmospheric pressure through an extended cracking coil of restricted cross section maintained at a cracking temperature wherein the oil breaks into vaporous form and is partially cracked, expanding the partially cracked oil into an enlarged cracking chamber maintained at substantially the same superatmospheric pressure and cracking temperature as in said coil and in which further cracking of the oil is effected, and removing the cracked and uncracked oil from the chamber while condensing the cracked vapors under superatmospheric pressure.

No. 1,585,381, granted May 18 to Charles J. Greenstreet, Chicago, assignor to Gasoline Corporation, Chicago, for an apparatus for treating heavy hydrocarbon oils which comprises a heating coil, means for heating said coil, an intake pipe leading to said coil and having two intake branches, one of said branches being adapted to

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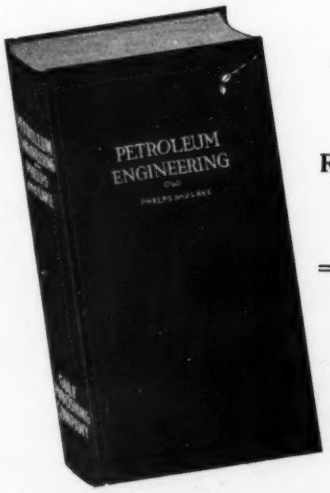

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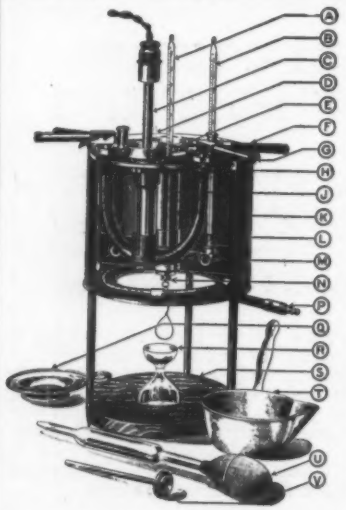

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be connected to a source of steam pressure and having therein a shut-off valve, a regulating valve for controlling the admission of steam, and a valve controlled vent to the atmosphere located between said shut-off valve and said regulating valve and the other of said intake branches being connected to a supply of oil and having a shut-off valve therein.

No. 1,585,456, granted May 18 to William Allinson, Des Moines, Iowa, for a process for renovating gasoline, comprising the forcing of the gasoline under pressure into the lower part of a body of settling chemical, heavier than the fluid to be renovated and through a restricted exit from the chemical container.

No. 1,585,473, granted May 18 to Lazar Wdeleanu, Berlin-Charlottenburg, Germany, for a motor fuel comprising an extract obtained from the distillate of mineral oil boiling between 120 degrees C. and 300 degrees C. by treating said distillate with liquefied sulphur dioxide, the resultant product being substantially free from sulphur dioxide and such hydrocarbons as do not boil between the temperatures of 130 degrees C. and 220 degrees C.

No. 1,585,496, granted May 18 to Ralph C. Holmes, New York; Frederick T. Manley, Houston, and Otto Behimer, Port Arthur, Texas, assignors to The Texas Company, New York, for a process of converting hydrocarbon oil which comprises forcing said oil through a coil and drum while applying heat to said coil and drum and allowing the vapors generated to develop pressure until decomposition of the hydrocarbon begins, then reducing the heat applied to the drum while securing it against substantial loss of heat through radiation and vaporization, and continuously supplying to the oil in the drum the necessary heat for decomposition by means of the stream of oil entering from the coil, the stream entering the coil being continuously commingling with a hot condensate separated out from the generating vapors.

No. 1,585,573, granted May 18 to Donald L. Thomas, New York, for an electro-chemical process of treating precracked unsaturated hydrocarbon compounds resulting from heat cracking of oils, in order to polymerize the same, which consists in subjecting such compounds to the silent discharge of a high tension electric current, while under the simultaneous influence of high temperature and pressure in order to produce by combination of their molecules a final stable product of different gravity and boiling point from the compound originally treated.

No. 1,585,687, granted May 25 to Auguste J. Paris, Jr., Bradford, Pa., for a process of altering the boiling points of hydrocarbon oils which consists in heating the oil to a temperature below its boiling point, mixing the oil without the separation of vapors therefrom with a gas, introducing the said mixture into a compressor, compressing said mixture for the purpose of heating the mixture, and subsequently cooling the resultant products and separating the liquids from the gas.

No. 1,585,922, granted May 18 to Alphonsus Jurrissen, Martinez, Cal., assignor to Simplex Refining Company, San Francisco, for a method of treating petroleum oils which comprises adding sulphuric acid to the oil; adding decolorized clay; and neutralizing with an alkali, the oil sulphuric acid, and alkali all being substantially free from water.

No. 1,586,130, granted May 25 to Milon J. Trumble, Los Angeles, for a distilling apparatus comprising means for raising oil to the desired temperature of volatilization, a separator into which the heated oil is delivered, means for regulating the discharge of oil from said separator in proportion to its entrance thereinto, means associated with the vapor outlet of said separator for definitely regulating the pressure within said separator, and means for converting the expansive heat energy of the vapor products from said separator into mechanical energy.

No. 1,586,132, granted May 25 to Milon J. Trumble, Los Angeles, for refining apparatus consisting, in an evaporator for treating petroleum oils, of a cylinder, two shafts, one projecting from one end of said cylinder and the other projecting from the other end of said cylinder, said shafts having a common axis about which said cylinder rotates; a tight casing enclosing said cylinder, a vapor inlet means for delivery oil onto said cylinder, a vapor outlet means for withdrawing oil vapor from said casing; two bearings, one supporting one of said shafts and the other supporting the other of said shafts; means for electrically insulating said bearings from said casing and means for impressing an electromotive force

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between one end of said cylinder and the other end of said cylinder.

No. 1,586,133, granted May 25 to Milon J. Trumble, Los Angeles, for an apparatus for cracking oils comprising a still, means for heating said still, a refluxing coil, means for delivering vapors from said still to said refluxing coil, means for delivering condensate from said refluxing coil to said still, a condenser, means for delivering vapor from said still to said condenser, walls forming a rerun chamber in which said refluxing coil is situated, means for delivering condensates from said condensate to said rerun chamber, means for delivering surplus liquid from said rerun chamber to said still, and means for condensing vapors produced in said rerun chamber.

No. 1,586,357, granted May 25 to Lazar Edeleanu, Berlin-Charlottenburg, Germany, for a process for converting mineral oils into light hydrocarbons of lower boiling point which consists in depriving said oil of the constituents soluble in liquefied sulphur dioxide, preparing a double compound of said mineral oils by treating with aluminum chloride, adding gradually the said double compound to the mineral oil to be converted, and causing the said double compound to react on the mineral oil by heating.

No. 1,586,376, granted May 25 to John Strother Miller, Jr., Rahway, N. J., assignor to The Barber Asphalt Co., Philadelphia, for a process for producing blown oil asphalts, of any desired consistency, by chemical condensation substantially without distillation, which process comprises heating oil and spraying the heated oil into a chamber and also supplying a gaseous oxidizing condensation agent thereto, regulating the temperature and the proportions of oil and oxygen to prevent ignition or substantial vaporization of the oil in said chamber.

No. 1,586,801, granted June 1 to Ingenuin Hechenbleikner and Thomas C. Oliver, Charlotte, N. C., for a continuous process of separating acid sludge obtained from the treatment of petroleum, consisting in subjecting the acid sludge to the action of steam under pressure greater than atmospheric to obtain a chemical separation of the sludge into its hydrocarbon and acid components, in withdrawing from the acid sludge while under treatment the said components in a chemically separated but mechanically intermixed state, and in then effecting a physical separation of said components.

No. 1,586,994, granted June 1 to Frank A. Howard, Elizabeth, N. J., assignor to Standard Development Co. of Delaware, for a process of cracking hydrocarbons comprising heating mercury in a closed system to a temperature above 700 degrees F., subjecting the hydrocarbons to indirect heat of the mercury vapor at such temperature, whereby the hydrocarbons are cracked by uniformly applied heat, taking off vaporous cracked products, and condensing the same.

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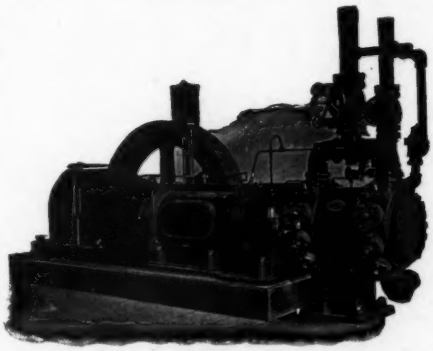

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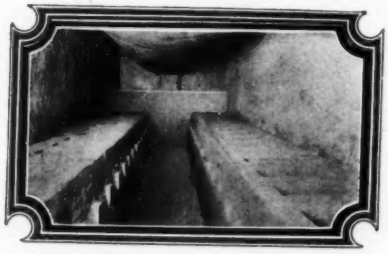
W-K-M Company ..... *
Woodward, Wight & Company, Ltd. 89
Wyatt Metal & Boiler Works ..... *
York Manufacturing Company 73

Eliminate still buckling
Get longer furnace life
Get uniform temperature
Get greater fuel economy
—on old or new stills
—with the
Plibrico Diffusing Furnace



THE direct impingement of flame against the still bottom is what causes over-heating and buckling.

The oil or gas fired Plibrico Diffusing Furnace prevents the flame from reaching the still bottom. Flame is confined to the tunnel-like doghouse combustion chambers. Heating is by diffusion. Buckling of the still bottom is absolutely overcome. Temperature can be accurately controlled the entire length of the still.

Longer furnace life and lower refractory maintenance cost are assured with this furnace—it's built of Plibrico, the double life furnace lining that hasn't a single joint. And you get greater fuel economy, too, as a result of the complete combustion of the oil in the doghouses.

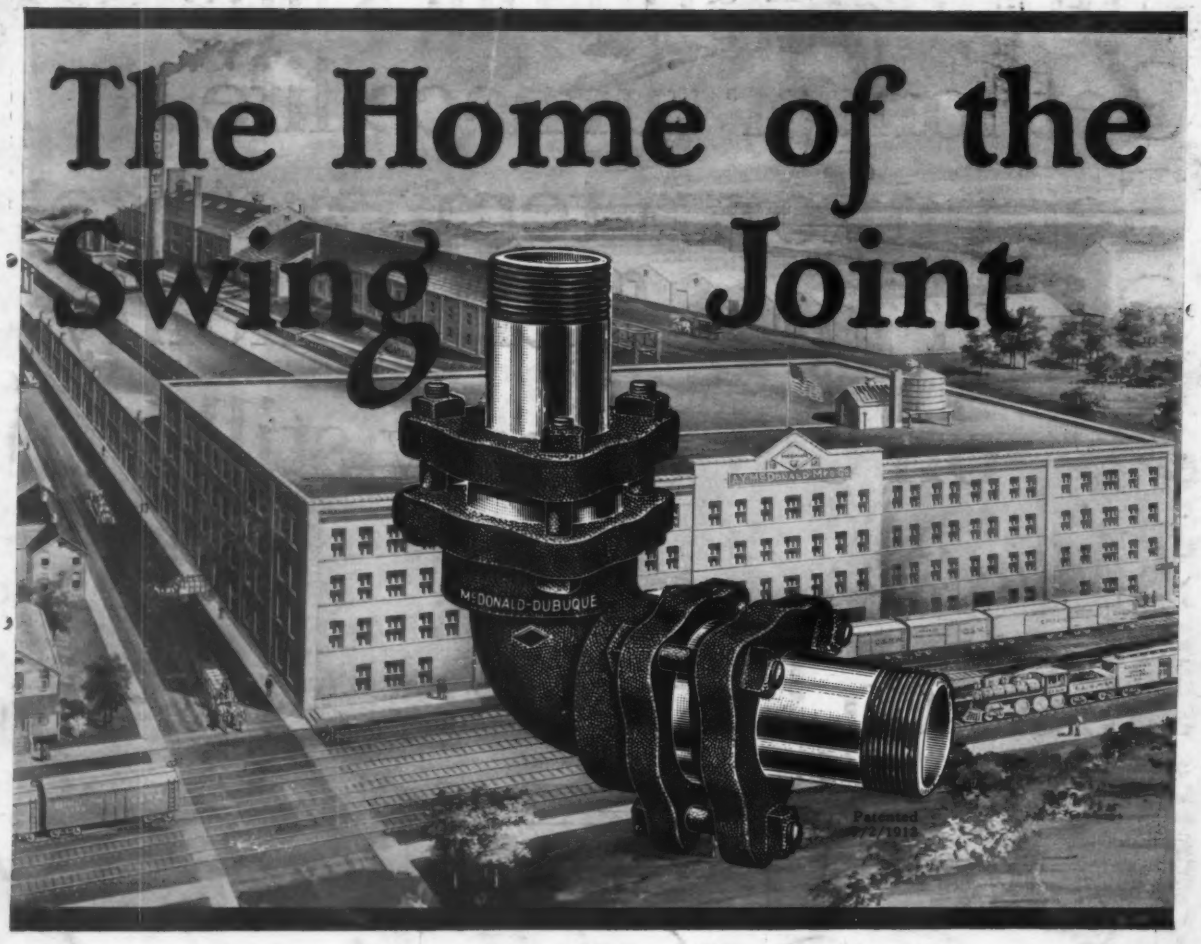
The Diffusing Furnace can be adapted to old as well as new still settings, and where coal-fired settings are being converted to oil. The engineering department will gladly make up drawings to suit your conditions if you'll send blueprints of your settings.

PLIBRICO JOINTLESS FIREBRICK COMPANY

1161 Clay Street, Chicago, Illinois

Factories: Chicago, and Trenton, N. J.

RNGM 7-Gray



Examine a McDonald Swing Joint and you'll know immediately why the McDonald Plant is known as "The Home of the Swing Joint."

Only from McDonald can you get the same free motion, durability and leak proof construction. McDonald's Swing Joints remain in service 7 and 8 years without re-packing. And they are so designed that they can be repacked easily and quickly.

Made in single and double styles in sizes from 1" to 12".

Specify McDonald's Swing Joints and you'll know why they are used all over the world.

"The Home of the Swing Joint"

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There's a McDonald Distributor Near You

McDONALD